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CONTENTS

	Page
Broadcasting and Television in Great Britain	45
Vavilov on Cultivated Plants. By Prof. S. C. Harland, F.R.S.	48
The Law of Patents. By R. G. Lloyd	49
A Handbook of Paper Chromatography. By Dr. R. Consden	50
Archæology in Ecuador. By Miss B. M. Blackwood	51
Physiology of Mitosis. By Dr. W. S. Bullough	51
Structure of Proteins. By Prof. John T. Edsall	53
Kodaikanal Observatory. By Dr. A. K. Das	55
Pasture and Fodder Development in Mediterranean Countries. By Prof. N. M. Comber	56
News and Views	57
Cosmic Rays and the Sun's Magnetic Field. By J. A. Van Allen and S. F. Singer; S. F. Singer	62
An Unusual Transformation of Isomeric Forms of Tetraacetyl D-Ribofuranose. By Dr. John Davoll, George Bosworth Brown and Donald W. Visser	64
Management in Scotland. By T. H. Hawkins	65
Lysenko's Latest Discovery—the Conversion of Wheat into Rye, Barley and Oats. By Prof. P. Maheshwari	66
Micro-magnetic Variations during the Solar Eclipse of February 25, 1952. By Prof. N. F. Astbury	68
Research Council of Israel: Annual Report for 1950–51	69
American Philosophical Society: Report for 1951	69
Metrology Laboratory of the College of Technology, Birmingham	70
Letters to the Editors:	
Selection of the Genetic Basis for an Acquired Character.—Prof. Paul G. 'Espinasse	71
Recent Echo Sounder Studies.—G. C. Trout, A. J. Lee, I. D. Richardson and F. R. Harden Jones	71
Trematode Life-Cycle enacted in a London Pond.—Dr. Ben Dawes	72
Moonlight and the Pregnancy of Malayan Forest Rats.—J. L. Harrison	73
Environmental Temperature and the Glycogen Content of the Frog's Liver (*Rana temporaria*).—Dr. C. L. Smith	74
Presence of Ferritin in a Marine Elasmobranch, *Scyllium canicula*.—Dr. Giorgio Tecce	75
A New Species of the Mystacocaridea (Crustacea).—Dr. Erik Dahl	75
Amino-acids in Legumes.—Dr. N. G. Baptist	76
Serological Properties of Human Blood Group *A* and *B* Substances.—R. A. Gibbons and Prof. W. T. J. Morgan, F.R.S.	77
A Relationship between the Secretion of the Blood Group Antigens and the Presence of anti-*O* or anti-*H* in Human Serum.—Dr. Ruth Sanger	78
Acetylcholine Esterase of the White Components of Blood.—Mrs B. E. Hines	78
Retinal Colour Processes caused by Intermittent White Light.—Prof. Koiti Motokawa and Mituru Ebe	79
Vitamin A Ester and Vitamin A Alcohol in the Serum of the Œstrogenized Immature Pullet.—V. E. Gardiner, W. E. Phillips, W. A. Maw and Prof. R. H. Common	80
Absorption from Intestine of Rats with Blind Self-filling Pouch.—D. W. Taylor	81
Thin-Film Interferometric Techniques for High-Magnification Topographical Studies.—Prof. S. Tolansky, F.R.S., and M. Omar	81
Photo-Elastic Determination of Boundary Stresses.—William Shelson	82
Effect of Scopoletin on Indoleacetic Acid Metabolism.—W. A. Andreae	83
Adsorption of Amino-acids on Sparingly Soluble Inorganic Solids.—D. J. O'Connor and F. Bryant	84
Deposition of Metal Films on Jelly-like Materials.—Edwin Rosenstiel	85

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BROADCASTING AND TELEVISION IN GREAT BRITAIN

THE Government's Memorandum on the Report of the Broadcasting Committee*, which was published as a White Paper on May 15, dropped one of the proposals of its predecessors which had been much criticized as likely to endanger the independence of the British Broadcasting Corporation and expose it to pressure from local sectional if not party political interests. It included three new proposals, however, which have met with strong independent criticism cutting right across political party lines. Nevertheless, following debates in the House of Lords on May 21 and 26, the White Paper was approved in the House of Commons on June 11 after a debate which left considerable room for doubt whether that approval would, in fact, have been obtained on a free vote. Afterwards, on June 19, the Prime Minister announced that the proposal for a new method of electing the governors of the British Broadcasting Corporation would be abandoned, and hopes were raised that the Government would no longer insist on making the question of broadcasting policy a party issue. The new licence and agreement of the British Broadcasting Corporation with the Postmaster General, published on June 13, were, however, adopted on June 23 after a debate in which the House of Commons again divided on party lines, and a new Royal Charter for the British Broadcasting Corporation was promulgated by Order in Council on June 24.

No matter who was mainly responsible, making broadcasting policy a party issue will be generally regretted by that large volume of responsible opinion which has followed the discussion of the future of British broadcasting since the Beveridge Committee reported early last year. The recent debates in Parliament made it clear that on all the main issues the division of opinion does not lie on party lines. On balance, the general trend of opinion seems to be in favour of continuing the present arrangements broadly on the lines recommended by the Beveridge Committee, without prejudice to the issue of monopoly, or to the exact form which regionalism or decentralization might take owing to technical development in the next few years. Indeed, the discussions in Parliament were marked by the same open-mindedness on the question of monopoly as has characterized most public discussions on broadcasting policy during the past two years, even on the part of those who expressed the greatest admiration for the achievements and character of the British Broadcasting Corporation. There is a widespread distrust of the policy of continuing indefinitely to give to any one body the responsibility for an instrument which can influence so powerfully for good or evil the minds of men and women.

The debates scarcely did justice to the extent to which this sense of social responsibility marks discussion of this question outside the Houses of Parlia-

* Broadcasting: Memorandum on the Report of the Broadcasting Committee. 1949. (Cmd. 8550.) Pp. 10. (London: H.M. Stationery Office, 1952.) 6d. net.

ment, particularly where television is concerned. It is this sense of social responsibility with regard to something the significance of which is at present only dimly appreciated that is behind the distrust with which anything like 'sponsored' or commercial broadcasting is widely regarded. It is considered unwise to place such powers anywhere but in the hands of a body with high standards of public service to maintain.

To this feeling the Government has done less than justice. Moreover, there is some room for doubt as to whether developments in television or in sound broadcasting, for example, in very-high-frequency broadcasting, need be quite so delayed by stringencies in capital resources, labour or materials as the White Paper suggests. The Government's inept handling of the whole matter has itself encouraged what are possibly quite unfounded doubts of its sincerity. By committing itself to a particular way of ending monopoly when there is a general readiness to consider impartially whether there are alternatives which can offer wider choice to the viewer or listener and at the same time maintain the present high standards of public service, it has exposed itself needlessly to the charges of yielding to sectional interests in matters which should be determined by technical inquiry and the public interest. It might be added that the Government's own proposals, so far as the British Broadcasting Corporation is concerned, may be expected, as indeed were those of Mr. Attlee's Government, to strengthen, through the inhibitions and restrictions they propose, the ossification which is almost inherent in any large organization with the passage of time.

Technical factors are a main reason for regretting the Government's determination to make broadcasting a party issue. The decision, moreover, does not assist a satisfactory solution of the other main problems—regionalism and the method of appointing governors. Here again an agreed and impartial solution demands more searching inquiry and constructive thought than was manifest in the Parliamentary debates. Disregarding speeches, such as those of the Lord Chancellor, which gave colour to the view that the White Paper represents a surrender to commercial interests or small pressure groups of extremists, even such reasonable and lucid speeches as those of Sir David Maxwell Fyfe in opening the debate on June 11 were sometimes a little naïve. The Government cannot claim, without discrediting itself, that it has had only a few weeks to consider the future pattern of broadcasting before the Charter and licence of the B.B.C. expired. It has been obvious since the Broadcasting Committee issued its report in January 1951 that this was an issue on which any government in power would have to make up its mind before the end of the year.

The immediate need is for all who realize how large an influence both sound broadcasting and television have come to play in the lives and minds of the community to seek to prevent any further surrender to such political or commercial interests and to work out both the technical and the administrative measures essential to prevent either the lowering of standards or the abuse of power. The real questions are not brought out clearly in the Government's White Paper any more than in that of its predecessor last July. Even Sir David Maxwell Fyfe's careful summary of the arguments for and against monopoly in his speech on June 11 gave insufficient weight to the extent to which the question of 'sponsored' programmes has widened out to the complex question of whether monopoly is the best form of organization for broadcasting. It is assumed too readily that the only alternative to the sponsoring of programmes by advertisers is monopoly, and there have been few signs of any disposition to enter on the hard thought which must precede the evolution of any new system which could avoid the dangers and disadvantages of either the present monopoly or sponsoring by advertisers.

That, however, is the immediate task. The Government's proposal to permit some element of competition in the expanding field of television, when calls on capital resources make this feasible, and the promise that Parliament should in any event have an opportunity of considering, before the licensing of the first station, the terms and conditions under which competitive television would operate, will at least give further time for reflexion. The Government's own memorandum admits that it would be necessary to introduce safeguards against possible abuses and that a controlling body would be required for this purpose; indeed, the conditions proposed are, in fact, so onerous that it is difficult to imagine anyone risking capital on them, and that they have aroused such alarm is rather a measure of the extent to which the Government's good faith is distrusted.

On this point two further observations may here be made. First, that distrust might well have been less had the Government proposed to take the first step towards competition in broadcasting by letting broadcasters compete in public service. There would then have been no reason for the suspicion that business interests rather than the desire to afford the viewing public some choice of programmes has been the deciding factor. The second point is that some technical opinion is strongly opposed to any such distinction being made between television and sound broadcasting, holding that they should be encouraged to grow together, instead of being kept apart. This argument may well gain further support if sound broadcasting and television are considered as cultural factors and even as determinants in the social life and thought of the nation. That aspect, so powerfully emphasized in a recent report by Robert Silvey, head of B.B.C. Audience Research, published in the *B.B.C. Quarterly*, received less than its due notice in the debates, apart from incidental reference by Mr. Herbert Morrison. Mr. Silvey's picture of the way in which television is spreading rapidly among the lower-income groups of Britain, who now hold much the larger proportion of viewers, and its effect on family habits and leisure, emphasize what an important social factor television has already become and what grave dangers could attend its abuse by any sectional or commercial interest.

This impression is confirmed by the admirable account of British broadcasting and television contained in Mr. Gorham's recent book, "Broadcasting and Television since 1900"*. This book, which should be read by everyone who desires to follow the present discussion on the future of British broadcasting, should correct many current illusions about the aloofness of the British Broadcasting Corporation and its failure to respond to public opinion. Implicitly, rather than explicitly, Mr. Gorham, in an eminently fair and readable book, shows the dangers inherent in the continuance of the broadcasting monopoly; but his book disposes of some of the wilder charges that protagonists of sponsored broadcasting have levelled against the British Broadcasting Corporation in the recent debates.

The book is important for another reason. It does not merely emphasize the moral issue, which Lord Reith stressed in his impressive speech in opening the debate in the House of Lords, and show clearly why the whole question of broadcasting should be treated in the same way and on the same plane as questions of education and other matters which profoundly influence the life and thought of whole communities; it also indicates clearly the right questions to be asked before we can hope to arrive at a considered policy and give it expression in a carefully worked out scheme. Such a scheme and policy the Government cannot yet claim to have laid before Parliament. Of some of the issues it appears to be only half aware. It agrees with the views of its predecessor as to educational broadcasting, without apparently appreciating the implication of this for any proposal to introduce an element in which public service is not to be the first and dominant consideration. Nor does it see, like Lord Waverley, in television an instrument of immense power, the social and economic implications of which are as yet but dimly appreciated. Without such a scheme, it is proposed, instead of keeping television and broadcasting in the hands of people whose sole purpose is to serve the public interest, to disturb a system which has served, and is admitted still to be serving, the country well.

Some of the speakers in Parliament, it is true, showed awareness of these questions, which should be answered before we decide how or even whether we should introduce competition. Lord Waleran, for example, pointed out that Germany, Italy and other countries, with or without a State monopoly, have overcome the wave-length problem by installing scores of very-high-frequency stations, whereas in Britain this is still experimental. Several speakers in the debates seemed no less conscious than Mr. Gorham of the backwardness of the B.B.C. in some respects during the post-war years, while other countries had made swift advances in technique.

These technical problems, however, appeared to be overlaid by the political aspects in the debate in Parliament, although they should be the decisive factors in determining the lines of development in the future. Nor were even the economic factors fully examined. Although the case for sponsored television rests largely on the assumption that it will bring in a contribution to broadcasting revenue which would otherwise be unobtainable, no one appeared to point out that the consumer ultimately pays in the increased cost of the advertised goods he buys, or to suggest any attempt to ascertain the amount of revenue which might be obtained. It was emphasized in the Commons debate that sponsored broadcasting is in effect subsidized broadcasting. Few besides Lord Samuel, Lord Hailsham and Lord Listowel challenged the proposal in both the present and last year's White Paper to raid the B.B.C.'s licence revenue. Lord Hailsham, however, showed the muddle into which this proposal leads, and Lord Kenswood gave a broad hint that an attempt should be made to discover whether the licence-holder would be prepared to pay a higher licence fee either to permit capital development or for improved television programmes before holding up indefinitely capital developments in television.

These are only some of the questions suggested by Mr. Gorham's book which are ignored in the White Paper and only cursorily examined, if at all, in these debates. None the less, while a free vote in the House of Commons might have gone against the Government's proposals, there was a widespread readiness to consider the question of monopoly with open minds, and no disposition to copy slavishly either the American or any other competitive system with the B.B.C. There was a general confidence that we should be capable of devising a British system which, whether or not it includes sponsoring, would supply, by healthy emulation in public service, the alternative programmes that are rightly demanded, competitively stimulate technical advance, and provide the necessary funds and opportunity for expression of regional and minority aspirations without debasing the standards of broadcasting of which Great Britain is rightly proud.

The debates in Parliament centred largely around the monopoly issue and sponsored broadcasting; the latter in particular, coupled with the Government's insistence on a party vote, tended to divert attention from one of the fundamental objections to the existing monopoly—that of a single employer. That aspect was dismissed rather summarily, and the proposals of the White Paper, particularly in regard to the regional councils, are unlikely to help the staff appreciably. It was made clear in the debates that the proposal by which the broadcasting councils will be responsible for the appointment of staff wholly employed in connexion with the Home Service programmes for which they are responsible is disliked by the B.B.C. staff, and the proposal was also criticized as administratively untidy if not unworkable.

Apart from the objection to this particular proposal on the ground of administrative efficiency, it can be criticized as a surrender to self-conscious and extreme nationalism, which might give too much scope for enthusiastic minorities to impose their tastes on the majority of their countrymen. More important, it may block the way for much sounder federal developments of the type advocated by Prof.

* Broadcasting and Television since 1900. By Maurice Gorham. Pp. 274. (London: Andrew Dakers, Ltd., 1952.) 18s. net.

Coatman. Decentralization such as he suggests, coupled with the possibilities which developments in very-high-frequency broadcasting have already put within our reach, should be able to satisfy all legitimate regional and cultural aspirations without detriment to the efficiency or the standards of the British Broadcasting Corporation.

For the rest, the new charter and licence provide for the B.B.C. to continue broadly on the existing basis. On the technical aspects of television, the Government will continue to seek advice from an advisory committee concerned with the development of television generally, and this advisory committee will also be asked to consider the best methods of introducing higher-frequency sound broadcasting, including the form of modulation to be adopted, on which consultation with the radio industry will be essential. The White Paper also points out that the establishment of new television services would require new stations and their ancillary services, such as studios, and that the radio industry must be advised as soon as possible in order to enable them to design and produce adaptors for existing television sets and new receivers capable of picking up either the B.B.C. programmes or those on other frequencies.

In this White Paper the Government accepts the view that, for many years, limitations on capital investment have prevented the B.B.C. from developing television in certain areas and from introducing very-high-frequency sound broadcasting. The latter view is not entirely accepted in the Beveridge Report, which included a memorandum on the subject by Mr. Geoffrey Crowther and Sir Robert Watson-Watt, and appears also to be disputed by Prof. Coatman when last year he pressed the Government to publish the report on very-high-frequency broadcasting submitted to the Postmaster General by the B.B.C. The Government considers that the B.B.C. has a continuing obligation to provide adequate national broadcasting services throughout the United Kingdom, and states that fulfilment of this policy must have first claim when labour and materials become available. Passages in the debate suggest that, where high-frequency broadcasting is concerned, neither finance nor materials need provide quite the obstacle to advance that is suggested, and Parliament seems to have missed in these debates an opportunity of insisting that the public should be given sufficient information for scientific men and technologists to form an independent opinion on this matter. As Prof. Coatman pointed out, it should not be left to confidential negotiation between the B.B.C. and the Postmaster General.

The most significant criticism of the proposals outlined in the Government's White Paper is that it shows insufficient imagination or sense of public responsibility for the immense power of sound broadcasting, and the possibly even greater power of television. That aspect was admirably stressed by Mr. Selwyn Lloyd in his minority report for the Beveridge Committee, and appeared to be the main reason for his disagreement with the majority report and urging the discontinuance of monopoly. Moreover, what was elsewhere urged in the majority report as to the tendency of sound broadcasting and still more of television to encourage passivity is substantiated by the findings of the report by Mr. Silvey already noted. Nor have the debates in Parliament removed this misapprehension, as was shown by the confused analogy with freedom of the press which the Lord Chancellor forced into his speech in concluding for the Government. That the Government has already reconsidered its proposals on the method of appointing governors may warrant the hope that it will think again on the major issues of the regional councils and the introduction of sponsoring. If in response to authoritative and impartial criticism the Government would take the whole question out of the whirlpool of party politics into which its own action has plunged it, a new charter and licence may still come into operation while the debate on monopoly and devolution proceeds. The scientific and technical factors in the development of both sound broadcasting and television should be urgently explored and publicly discussed in order to enable a decision to be taken on whether or not to abandon the existing system of monopoly. Moreover, if the decision were in favour of breaking the monopoly, it could then be done on the basis of a scheme embodying not merely safeguards which would ensure the dominance of the idea of public service and the prevention of the abuse of power, but would also ensure that the fullest possible use was made of the latest scientific and technical advances to give efficient administration and the maximum satisfaction to legitimate regional aspirations.

VAVILOV ON CULTIVATED PLANTS

The Origin, Variation, Immunity and Breeding of Cultivated Plants

Selected Writings of N. I. Vavilov. Translated from the Russian by Dr. K. Starr Chester. (Chronica Botanica, Vol. 13, No. 1–6.) Pp. xviii+364. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1951.) 7.50 dollars.

NIKOLAI IVANOVITCH VAVILOV was one of the outstanding contributors to the new science of plant breeding which developed during the first half of this century, following on the rediscovery in 1900 of the principles of Mendelian heredity. He was selected by Lenin to administer and direct agricultural research in the Soviet Union, and he became president of the Lenin Academy of Agricultural Sciences, which ultimately came to consist of a chain of four hundred experimental stations, scattered through the U.S.S.R. from Leningrad to Vladivostok.

Vavilov's most important contribution to science was on the genetical significance of the centres of origin of cultivated plants. The theory that cultivated plants can be assigned to known centres of origin was first put forward by de Candolle. Vavilov was able to co-ordinate the vast body of information which had become available since de Candolle, and he also developed the theory that genetical diversity is greatest in these centres of origin. The greatest concentration of dominant genes occurs at the centre

of origin, and since many of these have been lost by the more sophisticated varieties of the cultivated regions, it was evident to him that material from these centres can be of the greatest possible use to the plant breeder. His early studies of immunity to disease in plants led him to believe that it is in the centres of origin that immune types are most likely to occur. This now is perhaps over-simplified, since cases are known of recessive immunity away from the centre of origin.

Accordingly, Vavilov organized expeditions to countries where the most important economic plants were thought to have originated. Even before the Russian Revolution, he had explored Persia, Turkmenia and Bokhara. Dobzhansky states that "in 1920–23 he visited various parts of Middle Asia, including Tadjikistan and Pamir. In 1924 he covered a long and arduous itinerary in Afghanistan. In 1925 he went to Khiva. In 1927 he studied the Mediterranean region from Portugal and Morocco to Syria and Trans-Jordan, and made an expedition to Ethiopia and Somaliland. In 1929 he visited Chinese Turkestan and Songaria. Finally, in 1930 and 1932–33 he travelled and collected extensively in Mexico and in central and south America". Altogether, he and his colleagues surveyed sixty different countries.

In this way he was enabled to make a beginning in the great and still unaccomplished task of a survey of world resources of economic plants, and of the formation of a series of living museums in which all the genetical variability of a plant could be made available to workers not only in the U.S.S.R. but also in other countries. His collection of wheat varieties, for example, numbered 26,000 types.

Vavilov was no narrow nationalist. He believed that our main task is to feed, clothe and house the millions of underprivileged human beings who still comprise the bulk of the world's population. For this work, the whole world must be called on to help and serve mankind.

The second important theory of Vavilov is that known as "The Law of Homologous Series in Variation". This puts forward the idea that related species, and even genera, tend to exhibit parallel hereditary variability. This concept has also been of value to the plant breeder, in that it has enabled the existence of useful but unknown variants to be predicted in a given crop.

Although Vavilov's work has long been known and appreciated by non-Russian workers, they have hitherto not been able to read it in complete form. But here in this well-produced and well-translated book are to be found Vavilov's most important writings.

There is an introductory essay on plant breeding as a science. All those that maintain that plant breeding is an art and not a science—an art for which there is a 'flair' possessed by a few—should read and profit by this chapter. Plant breeding is no longer merely an art; it is a branch of biological engineering.

The first section of the book proper covers the subject of the "Phytogeographic Basis of Plant Breeding". All the main centres of origin of cultivated plants, both primary and secondary, are here discussed in detail. Subsequent sections deal with "The Law of Homologous Series in the Inheritance of Variability", and the "Study of Immunity of Plants from Infectious Diseases". The third section is a complete and masterly survey of the "Scientific Bases of Wheat Breeding", and there is a concluding section containing a selected bibliography of the basic world literature on the breeding and genetics of wheat, up to 1935.

A perusal of this classical contribution to biological literature makes it more than ever mysterious why genetical science was destroyed in the Soviet Union at the very time when all the tools were ready to make an unprecedented advance in its practical application to agriculture. The book is a complete defence of plant-breeding technology as we are slowly coming to know it, against the pretensions of the Lysenko school who are now responsible for applied genetics in the Soviet Union. It will be read by all plant breeders; they can scarcely fail to be stimulated by the still novel points of view which abundantly occur. If its lessons are properly appreciated by those who guide our political and economic destinies, we may not attain for a long time to come the twenty thousand workers whom Vavilov had in his research institutes in 1934; but at least we shall hear less of the preposterous story of a possible surplus of biologists in Great Britain during the next five years.

The life and work of Vavilov must be viewed against the background of the political ideology of the Soviet Union, and this book should be read conjointly with the story as told by Huxley and Zirkel of how genetics was destroyed in that country after a long period of hostility. Vavilov died, defeated and disgraced, in Siberia in 1942. It is therefore altogether fitting that his best work should now be made available to the wide audience of the Western world.

S. C. HARLAND

THE LAW OF PATENTS

Terrell and Shelley on the Law of Patents

Ninth edition. By K. E. Shelley, Q.C. Pp. lxv+680. (London: Sweet and Maxwell, Ltd., 1951.) 105*s.* net.

"TERRELL on Patents" has been for more than sixty years the standard text-book on the law of patents. This new edition, "Terrell and Shelley on Patents", rendered necessary particularly because of the passing of the recent Patents Act, has been prepared by Mr. K. E. Shelley, one of the most experienced of the small group of Her Majesty's Counsel practising at the Patent Bar. He is to be commended for producing so comprehensive and yet so succinct an account of the law of patents.

The British patent system was subjected to a detailed investigation by the Swan Committee set up in 1944 by the then president of the Board of Trade, under the chairmanship of Sir Kenneth Swan. Important and far-reaching innovations in patent law were recommended by this Committee, and the large majority were incorporated in the Patents Act, 1949.

As Mr. Shelley points out in his preface, patent law falls into two sharply distinguished categories: there is the purely administrative side, which is primarily concerned with the actual procedure of obtaining a patent; and there is the judicial aspect, which is concerned with the interpretation which the courts have placed on general concepts contained in the Patents Acts, such as 'manner of manufacture', 'new', 'useful', etc.

No attempt has been made in this edition to set out every detail of procedure of the administrative branch of the law, though the relevant sections of the Act and the Rules are printed in full in the appendix. The judicial aspect has, however, been

very fully treated. Verbatim extracts of the leading judgments on each important topic have been quoted, and the author has not hesitated to criticize many of the decisions of the court. As he points out in his frankly written preface, "It is inevitable that in some cases a Court, approaching a problem of patent law for the first time, has come to a decision which seems erroneous to the specialist who has over a period of years reached a different conclusion, possibly through giving more weight to expediency in practice than to abstract rules of construction or the dictionary meaning of words. Such decisions have been frankly criticized in the following pages". It will be undoubtedly helpful to many a practitioner to have these critical and constructive comments.

In the contents are set out the principal changes enacted by the Patents Act 1949, many of which are likely to make the law more favourable to inventors who patent their inventions. New methods of processing or testing applicable to the improvement or control of manufacture are now patentable. New chemical substances may be patented *per se*, without reference to any particular method of manufacture, and this constitutes a substantial change in the law which is of importance in the chemical industry. Patents of addition are no longer to be invalidated by publication of the main patent or user of the invention which is described in it. Thus an opportunity is now afforded to a patentee to file a fresh application for letters patent covering details of his invention in the light of actual experience. This is likely to avoid the patentee being deprived in future of a chance of obtaining an effective monopoly for his invention.

The book commences with a brief history of the development of patents and the nature of patentable inventions. Next follows a chapter on the applicant and the application, including a valuable résumé of the difficult question which so frequently arises in practice—the extent of the ownership by an employee of an invention conceived while in the employment of a firm. The requirements laid down by the Act as to the contents of the specification and the grounds upon which the specification may be attacked before and after the grant of letters patent are set out in the succeeding chapters. The chapter on the action for infringement, the method by which a patentee in the last resort can enforce his patent privileges, contains an excellent summary of the principal matters to be considered and a review of the more important cases. The sections of the Act dealing with action which can be taken to deal with any abuse of the monopoly granted by way of patents are fully analysed. Now that government departments are so closely connected with industrial research, the sections of the Act dealing with questions of compensation payable by the Crown in respect of use of patented inventions are of considerable practical importance. These questions have been clarified by the new Act and are carefully summarized. No mention, however, is made of the facilities whereby a patentee may in certain circumstances have his claim dealt with by the Royal Commission on Awards to Inventors set up under the chairmanship of Lord Cohen.

While retaining the general layout of the former editions of this standard text-book, this new edition provides a more compact and logical approach to a difficult subject than did its predecessors. The book will be welcomed by all who are in any way concerned with inventions and patents. R. G. Lloyd

A HANDBOOK OF PAPER CHROMATOGRAPHY

Papierchromatographie

Von Dr. Friedrich Cramer. (Monographien zu *Angewandte Chemie* und *Chemie-Ingenieur-Technik*, Nr. 64.) Pp. 81+2 plates. (Weinheim-Bergstr.: Verlag Chemie, G.m.b.H., 1952.) 9.80 D. marks.

Of all forms of chromatography, the paper chromatogram has proved the most popular and is now universally established. Since its inception in 1944, many articles have appeared reviewing its applications; but while these have served a useful purpose, the time has come for something more permanent than a review, and which brings together all the important features and is designed to be a work of reference. This has been accomplished by Dr. F. Cramer in "Papierchromatographie".

The monograph is arranged in two parts, general and special. The first gives the principles underlying the different types of chromatogram. Countercurrent distribution is discussed and linked up with partition chromatography. The paper chromatogram is discussed as a partition process, and the arguments against it are also presented. After the theoretical sections, there follows a full and detailed account of the practical aspects of paper chromatography. An outline of the various methods of quantitative analyses is next presented, and then the use of paper, either in sheet or powder form, for isolations. Though not strictly chromatography, paper electrophoresis is usefully included, and this completes the general part.

The special part of the book is concerned with applications to all the important classes—amino-acids, sugars, purines, and so on. The treatment is thorough; many tables of R_F values are given, and full details are provided of solvents, reagents, and some of the more important quantitative methods. Non-aqueous and reversed-phase chromatography and the use of radioactive tracers are not overlooked. The emphasis throughout is on sheet chromatograms; the use of paper and starch in columns is mentioned only briefly.

In a work of this kind, so packed with information, it is perhaps inevitable that errors and omissions occur, but these are remarkably few. The only serious criticism that one can offer is that there is no subject index, which is essential in such a work of reference. Of the few errors, there are one or two references which do not relate to the subject-matter in the text. Of the omissions, there is no reference to Durrum's important contributions on paper electrophoresis[1]. In the section on peptides, which is rather too brief, more could have been said about the techniques for determining the order of amino-acid residues in proteins and polypeptides, and a table of R_F values of peptides and derivatives might have been included. There is no mention of the theories relating R_F values of peptides with the thermodynamics of their structure[2]. A 'map' of the amino-acid spots of a two-dimensional chromatogram would have been useful. Though the illustrations are clear and the colour photographs are good, it is rather a pity that a better two-dimensional chromatogram was not chosen for reproduction.

However, these are small blemishes in a work which provides all the information that one expects from a good text-book. It is up to date, well arranged, generously illustrated and clearly printed on high-quality paper. The price, at present rates of exchange,

is reasonable, and it is to be hoped that the book will be generally available outside Germany. Is it too much to ask for the monograph to be supplied in stiff covers? This would, of course, raise the price somewhat, but would be worth while as a protection against inevitable wear and tear. An English translation would undoubtedly widen its appeal. This book will be found invaluable by all, whether experienced or not in the subject, and Dr. Cramer and the publishers are to be congratulated on the production of an attractive text-book of outstanding importance.

R. CONSDEN

[1] Durrum, E. L., *J. Amer. Chem. Soc.*, **72**, 2943 (1950).
[2] Martin, A. J. P., Biochem. Soc. Sym., **3**, 4 (1949).

ARCHÆOLOGY IN ECUADOR

The Archæology of the Santa Elena Peninsula in South-west Ecuador

By G. H. S. Bushnell. (Occasional Publications of the Cambridge University Museum of Archæology and Ethnology.) Pp. xv+155+5 plates. (Cambridge: At the University Press, 1951.) 42*s*. net.

THIS volume presents the results of Dr. G. H. S. Bushnell's field-work in an area until now practically unknown archæologically, together with a discussion of the small corpus of relevant comparative material, mainly the work of Spanish archæologists.

Dr. Bushnell's excavations indicate the presence on the Santa Elena Peninsula of three separate cultures: Guangala, Engoroy and Manteño. They were nowhere found in stratification, but there is some evidence indicating this sequence. Manteño, previously known from Manabí as probably the last period before the Spanish Conquest, the author considers to be intrusive in the Peninsula. He is rightly cautious about dating, but produces some comparative material suggesting that Guangala, the earliest found, is later than A.D. 900.

Detailed descriptions of these three cultures are given. There is also a brief chapter on a possible pre-Guangala culture (now being further investigated by E. N. Ferdon, jun.), and another on an early post-Conquest cemetery at La Libertad, partly excavated by the author.

Besides much characteristic pottery, sites belonging to all three cultures yielded tools of stone and shell. In Guangala and Manteño sites metal tools and ornaments were found; the single Engoroy site produced no metal. Among Manteño objects were two celts. That these at least were of local manufacture is indicated by the close correspondence of one of them to a clay mould excavated at La Libertad by Mr. A. J. R. Murray in 1923–24 (now in the Pitt Rivers Museum, Oxford). A metallurgical report by the British Non-ferrous Metals Research Association on some of the metal objects (Appendix *A*) shows them to be of copper and not of bronze.

Most of the human remains were either calcined or in very poor condition. In Appendix *B*, Dr. W. L. H. Duckworth reports on the seven skulls of the Guangala period which were capable of preservation. They show artificial deformation at the occiput such as is characteristic of Peruvian skulls, which they resemble in other details also.

In culture, however, Dr. Bushnell thinks that the Guangala period may prove to owe more to Central America than to Peru. For Engoroy he can suggest no outside relationship. He agrees with the view held by Saville from his work at Manabí that the Manteño culture shows "a considerable degree of independence of outside influence".

Although many problems remain unsolved, Dr. Bushnell's work has put into place a piece of the jig-saw puzzle which will eventually be completed to produce a picture of the archæology of coastal Ecuador. The book is well illustrated, with maps and plans, numerous line-drawings, photographs, and an excellent colour plate of Guangala pottery types. It should give a good start to the welcome new series which it inaugurates.

B. M. BLACKWOOD

PHYSIOLOGY OF MITOSIS

The Mitotic Cycle

The Cytoplasm and Nucleus during Interphase and Mitosis. By Dr. Arthur Hughes. Pp. viii+232+16 plates. (London: Butterworths Scientific Publications, Ltd., 1952.) 35*s*. net.

IT is rightly emphasized on the dust-cover of this valuable monograph that the process of cell division presents one of the most difficult problems the experimental biologist has yet attempted to solve, and, if this present account of the mitotic cycle is not an easily flowing and well-balanced narrative, the reflexion is not on the author but on the present state of our knowledge of the subject. There is a large and widely scattered literature of unequal relevance and of uneven quality. The lines of advance have been largely dictated by considerations of the materials and techniques available, and a strong medical bias is also evident. Thus we now have an extensive knowledge of the early cleavage of a certain few eggs, of the growth in culture media of a certain few tissues, of the methods of induction of cancerous growths, and of the methods of mitotic inhibition by a multitude of diverse substances. The obvious questions posed by the mitotic activity of normal animal and plant tissues have been almost entirely neglected, although very recently a start has been made towards their solution.

The book gives an extensive survey of this patchy subject, and it will for many years remain a valuable tool in the hands of those who are working in or around this field of research. Chapters are devoted in turn to the nucleic acids, to the cytoplasm and nucleus in interphase and in division, and to the experimental methods of analysis of the problems presented. Sections are contributed by Dr. M. M. Swann on the spindle, and by Dr. C. Waymouth on the nature of the stimulus to mitosis.

Because this is such an extensive review, the few gaps that are left unfilled appear all the more obvious. In particular, it has to be noted that the short section on hormones and mitosis gives a surprisingly inadequate account of our present fairly extensive knowledge. Another lesser criticism which may also be offered is that the long reference lists are arranged in order of mention and not, as is more customary in biological works, in alphabetical order. This is particularly regrettable, since these lists are one of the most valuable features of the book.

Such criticisms do not, however, invalidate the final judgment that this is certainly the best review of the difficult subject of cell division yet to be published, and its appearance will be warmly welcomed.

W. S. BULLOUGH

Elsevier's Encyclopædia of Organic Chemistry

Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 14: Supplement; Tetracyclic and Higher-Cyclic Compounds except Steroids and Triterpenes. Pp. xxxi+938S+Ind. 113. (Amsterdam and New York: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) To subscribers, £23.

THIS is the first of the supplementary volumes of "Elsevier's Encyclopædia". It is mainly concerned with the polycyclic aromatic hydrocarbons and their derivatives, and summarizes the literature of the decade 1937–46. There are also references to some of the more important publications of later years, up to and including 1951. The size of this volume bears witness to the large amount of attention which has been devoted to polycyclic aromatic hydrocarbons in recent years; it is pointed out in the preface that the number of ring systems known has undergone a 60 per cent increase, having risen from 233 to 378. The original Vol. 14 consisted of 611 pages, excluding indexes, and included also the steroids and triterpenes which will form the subject of a second part of the supplementary volume.

In general, this supplement follows the pattern of earlier volumes, although a useful novel feature is the inclusion of references to the patent literature. The ring systems dealt with include those of the benzfluorenes and fluoranthene, 1 : 2-benzanthracene and naphthacene, chrysene, pyrene, cholanthrene, pentacene, dibenzanthracenes, picene, benzopyrenes, perylene, and coronene. Recent work on some of the vat dyes is also summarized; these include anthanthrone, pyranthrone, dibenzanthrone and *iso*-dibenzanthrone. There is also reference to some natural products, such as the diterpene phyllocladene and related compounds, and the photodynamic pigment hypericin.

The volume conforms to the customary standard of excellence in production, and will be of particular interest to those who have occasion to consult the literature of carcinogenic hydrocarbons and their derivatives. There are extensive references to their biological properties as well as to preparation and reactions. The volume will also be welcomed by the increasing body of chemists who make regular use of the "Encyclopædia". Unfortunately, only a relatively small area of the field of organic chemistry has been covered by the volumes which have been published so far.

Notions fondamentales sur les vernis et peintures

Par Louis Kientz. Deuxième édition revue et corrigée. Pp. xxi+234. (Paris: Libr. Gauthier-Villars, 1952.) 1300 francs.

M. LOUIS KIENTZ has written this work with the express purpose of providing a modern text-book to which all those who are connected with the different branches of the paint and varnish industry may refer if they wish to learn about recent scientific and technical developments in the industry. He therefore starts by outlining a few basic ideas of chemistry and physics appertaining to paints and varnishes, and discussing the chemistry of the raw materials used, namely, resins, oils, solvents and pigments. He then describes the processes involved in the different stages of the manufacture of various types of paints and varnishes, which are grouped into families under a system of classification introduced during the War by the Comité d'Organization des Peintures et Vernis (C.O.P.V.). There is a final chapter devoted to a survey of methods used for testing both raw materials and the finished paints and varnishes.

The subject-matter dealing with the actual manufacturing processes is clearly and logically presented, but the earlier chapters discussing the purely chemical aspects of the subject are open to a certain amount of criticism. Thus, the drying of oils is discussed without any reference to recent work on the hydroperoxide theory, and the polymerization reactions involved in the formation of stand oil are inadequately treated. It is also misleading, in a modern text-book, to give wood distillation as the only source of acetone. Furthermore, there are a large number of irritating misprints in simple chemical formulæ and equations, and the structural formulæ of compounds such as abietic acid, dipentene and pinene are quite unintelligible and show a complete disregard for the tetravalency of carbon. It is regrettable that these errors occur in what purports to be a revised and corrected edition; they reduce the value of this book, which in other respects may be regarded as a welcome addition to the technical bibliography of the paint and varnish industry.

A. E. A. Werner

A Guide to Bird Finding East of the Mississippi

By Olin Sewall Pettingill, Jr. Pp. xxi+659. (New York and London: Oxford University Press, 1951.) 30*s*. net.

THE title of this book is rather misleading, since it is really a guide-book to the best places to see birds in the twenty-six States east of the Mississippi. The volume is arranged under States, with each locality printed in capital letters, followed by the size in acres, or square miles, in brackets, and a statement whether it is a reserve or park under Federal or State management.

After a brief description of the type of country found in the reserve, some of the more interesting birds are mentioned and directions given how to get to the place. Visitors are warned always to call at the headquarters of a park or reserve before entering, and in the case of a private reserve to make sure of getting the owner's permission. Towns which have museums where there are collections of birds are referred to with a brief description of their contents.

As the author points out, this work was a co-operative undertaking, in the compiling of which three hundred people contributed information. It contains a great deal of interesting information regarding the reserves in the eastern United States, and might well be copied in a modified form in Great Britain.

Dyeing with Coal-Tar Dyestuffs

The Principles Involved and the Methods Employed. By Dr. C. M. Whittaker and C. C. Wilcock. Fifth edition. Pp. vii+375+17 plates. (London: Baillière, Tindall and Cox, 1949.) 21*s*. net.

THOUGH essentially technological, this book makes an approach to a synoptic view of the subject, and should be of value to students of textile chemistry. Theoretical treatment of the subject is notably lacking, however. Thus no adequate attempt is made to show how dyeing-rate depends upon a diffusion process, or how dyeing-rate and dyeing-equilibrium are affected by temperature and by salt addition. In view of the well-known pioneer work of the senior author, these omissions are surprising.

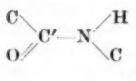
S. M. Neale

STRUCTURE OF PROTEINS

RECENT developments in the study of proteins and synthetic polypeptides have raised hope that some fundamental patterns of protein structure may be elucidated in the not very distant future. Progress in experiment and theory has been revealing to a degree that could scarcely have been anticipated even five years ago. The Royal Society discussion of May 1 on "The Structure of Proteins", organized by Prof. W. T. Astbury, served to focus the attention of many investigators on present achievements and on the deep and baffling problems that still remain to be solved.

The background of the discussion may be briefly sketched. Beginning about twenty years ago, Prof. Astbury and his associates studied the proteins of the keratin–myosin–epidermis–fibrinogen (k–m–e–f) group, all of which show a general similarity in the wide-angle X-ray diffraction pattern, and all of which are capable of existing with the polypeptide chains in a folded (α) or extended (β) configuration. The other great class of fibrous proteins, the collagens, show a fundamentally different type of pattern. The evidence is now overwhelming that protein molecules are composed of polypeptide chains; hence it was sought, by Astbury and others, to formulate configurations for such chains which might explain the observed facts. Thus in 1943 M. L. Huggins proposed a number of possible configurations, some of them helical. In 1950 Sir Lawrence Bragg, J. C. Kendrew and M. F. Perutz examined the problem in great detail, discussing numerous possible patterns of folding of the chains, and for the first time defining the proposed structures with considerable precision by giving the co-ordinates of the atoms to the nearest 0·1 A. However, the results which have aroused the strongest support, and the sharpest criticism, are those of Prof. L. Pauling and Dr. R. B. Corey, whose views were fully presented at the meeting. Fortunately, Dr. Corey was present in person to discuss the dimensions of the polypeptide chain; the involuntary absence of Prof. Pauling was keenly regretted by all at the meeting, and in his absence his paper was presented by Dr. E. W. Hughes.

Dr. Corey's contribution to the discussion rested upon precise studies of the crystal structures of amino-acids and peptides, which he and his associates have carried out over a period of many years. These led to a picture of the most probable dimensions of the amide group, the repeating unit of the polypeptide chain; the results are summarized in the following diagram and table.



Distances		Bond angles	
N—C	1·47 A.	C—N—C′	123°
N—C′	1·32 A.	C—N—H	114°
C′—O	1·24 A.	H—N—C′	123°
C′—C	1·53 A.	N—C′—O	125°
		N—C′—C	114°
		O—C′—C	121°
		C′—C—N	110°

Fundamental to all structural considerations is the large amount of double-bond character in the C′—N bond of the amide group, indicated by the short interatomic distance of 1·32 A., contrasted with the normal single-bond value for the C—N linkage, which is near 1·47 A. This implies that all the atoms in this group shown in the formula lie in the same plane, or very nearly so. A twisting of the atom pairs on either side of the C′—N linkage by 10° out of this plane should lead to a strain energy near 1 kcal. per amide group; a 20° twist should produce a strain energy nearly four times as great. Given this planar configuration, the arrangement of the outer carbon atoms may either be *trans*—as shown in the figure—or *cis*. The amide group in all peptides yet studied, and also in N-acetylglycine, has been found to be in the *trans* configuration, and the planarity of the group is maintained to a high degree of approximation.

The paper of Pauling and Corey considered the criteria for acceptable configurations of polypeptide chains in proteins, and laid down certain postulates concerning them. First, interatomic distances and bond angles must be the same, or nearly the same, as those found already in amino-acids and peptides. Secondly, the NH and CO groups must be linked by hydrogen bonds, with reasonable values for the N—H . . . O distance, and with a close approach to linearity of these three atoms. Thirdly, the planarity of the amide group must be maintained. Several configurations which meet these requirements have been formulated; two are helices. The one which appears most important is the α-helix, containing very nearly 3·7 amino-acid residues per turn of the helix, the translation per residue in the direction of the axis of the helix being calculated as 1·49 ± 0·04 A. Precise values for the co-ordinates of the atoms in this helix have been given, and X-ray intensities for scattering from such a structure have been calculated and compared with observed values. The most striking piece of evidence suggesting the existence of the α-helix in proteins was the observation of Perutz of an X-ray reflexion at 1·47–1·50 A., corresponding to a repeating distance along the fibre axis, in all proteins and synthetic polypeptides having the α-configuration. The discovery was made in 1951, following the formulation of the α-helix; it was later recognized that the same reflexion had been observed in certain types of keratin by I. MacArthur in 1943; but its possible implications were not then apparent.

If the helix is to form part of a repeating unit in a crystalline structure, an integral number of residues must be obtained after a reasonable finite number of turns; Pauling has suggested eighteen residues in five turns, or eleven residues in three turns, as probable repeating units within the limits 3·6–3·7 residues per turn. In particular, he proposed an α-helix with eighteen residues in five turns as the basis for the structure of the synthetic substance poly-γ-methyl-L-glutamate, giving a unit length along the fibre axis of 27 A.

Another possible helix, the γ-helix, has about 5·15 residues per turn, and a fibre axis length per residue very near 1 A. This helix has a hole down the centre large enough to admit water molecules; there is at present little evidence, however, to suggest that such a structure exists in Nature, and there are reasons for believing it to be unstable.

Finally, Pauling and Corey have formulated three different kinds of 'pleated sheets'—briefly denoted as the polar, the parallel and the anti-parallel—contisting of sets of peptide chains, more fully extended than in the helices, linked by hydrogen bonds between the chains, rather than within the chain, as in the

helix models. The polar pleated sheet they believe to be an improbable structure; the other two, with a length per residue along the chain direction of 3·34 A., are suggested as models for the β-keratin structure.

For collagen they have proposed an elaborate structure, involving three intertwined polypeptide chains, held together by lateral hydrogen bonds. In each chain two *cis* residues are followed by one *trans* residue; every third residue may be proline or hydroxyproline. However, it is now admitted that this structure requires modification.

The principal debate at the meeting centred around the validity of the α-helix. Besides the Perutz–MacArthur spacing at 1·5 A. in many proteins, Pauling cited the recent calculations of W. Cochran and F. H. C. Crick[1] on poly-γ-methyl-L-glutamate in its favour, as well as the radial distribution functions calculated by D. P. Riley and U. W. Arndt[2] for bovine serum albumin from X-ray data on the powdered protein. The latter work was discussed briefly at the meeting by Dr. Riley himself.

On the other hand, some grave difficulties for the α-helix were pointed out. The calculated density of α-keratin, for example, as Astbury pointed out, should be about 1·15 if it is assumed to be composed of α-helices in hexagonal packing. Modification of the packing could give a somewhat higher density, but not nearly enough to explain the observed density near 1·3. The characteristic X-ray spacing at 5·1 A. in α-keratin and other α-proteins should not be given by the α-helix, which instead should give a repeating spacing in the range 5·22–5·62 A. The 5·1-A. reflexion has been interpreted by V. Schomaker (as reported by Pauling) as due to an abnormality in background intensity of poorly crystallized material; but this explanation was obviously not considered satisfactory by some who were present. Moreover, Dr. C. H. Bamford reported new X-ray studies on poly-γ-methyl-L-glutamate, carried out at the Courtauld Laboratories, Maidenhead, which indicate that the repeating unit along the fibre axis is at least 43·2 A., and may be twice as great. If this is correct, it would rule out the view that the fundamental repeat is that of an α-helix with eighteen residues in five turns, as proposed by Pauling. (Attention may be directed at this point to the recent report of Yakel, Pauling and Corey[5] on fibres of the same substance. They find a hexagonal unit cell with $a = 11{\cdot}58$ A., $c = 26{\cdot}33$ A., the latter value being in excellent agreement with that expected for an α-helix having eighteen residues in five turns. Moreover, the intensities of the X-ray reflexions agree extremely well with those calculated for the α-helix, the β-carbon atoms being assigned to position 2, in the notation of Pauling and Corey. This evidence, together with the striking calculations of Cochran and Crick[1], strongly supports the view that poly-γ-methyl-L-glutamate fibres have the α-helix structure, or something very close to it (see also Bamford *et al.*[6]). It would require only a very small distortion of the helix to give a large change in the repeat distance along the fibre axis, and such distortions may well occur in certain cases, depending on the method of preparing and drawing the fibre. Further work is certainly needed to resolve the puzzle completely; but the balance of the evidence on these synthetic polypeptides seems to be in favour of the α-helix.) Dr. Bamford favours a structure for α-proteins in which there are only two amino-acid residues for a repeating distance of 5·1 A. along the fibre axis, instead of three, as in the Pauling–Corey α-helix or in another structure proposed earlier by Astbury. However, this hypothesis has serious difficulties also, which some consider to be fatal.

One of these difficulties was brought out in the report by Dr. K. M. Rudall on the elastic properties of myosin, epidermin and fibrin. Films and fibres of these proteins were stretched under conditions in which they were fully converted into the β form, and then caused to shorten into the α form. The maximum contraction in all cases seems to be about 55 per cent of the stretched length. This figure corresponds closely with what would be expected on the Pauling–Corey hypothesis—contraction from a pleated sheet with 3·34 A. per residue to an α-helix with 1·50 A. per residue—but could also fit the Astbury model for α-keratin. It seems irreconcilable with a model involving only two residues in a fibre axis distance of 5·1 A., unless the α–β transformation is supposed to be far less complete than it appears.

The Pauling–Corey collagen structure—which the authors themselves now state requires revision—was criticized by Prof. J. T. Randall, who objected to the mixture of *cis* and *trans* residues involved, and to the failure of the structure to explain the infra-red dichroism. Prof. Randall proposed an alternative structure, which appears to avoid these difficulties, and which he believes to give a better fit with the X-ray data (see *Nature*, June 21, p. 1029).

Work of Dr. Barbara W. Low at Harvard University (reported to the meeting by J. T. Edsall) on crystals of acid insulin sulphate, indicating the presence of oriented polypeptide chains, has recently been published[3]. Dr. Low also reported a new type of helical model, intermediate between the α- and the γ-helix; each amide group is hydrogen-bonded to the fourth one beyond it, and the distance per residue along the fibre axis is about 1·13 A. This model requires slight distortion of the bond angle of the α-carbon; calculations on the model are still in a preliminary stage. Dr. Dorothy Crowfoot Hodgkin presented Fourier projections of the phenylalanyl (*B*) chain of insulin, using the sequence of amino-acid residues determined by F. Sanger, and assuming the chain to be coiled in an α-helix.

A. Elliott discussed the infra-red absorption and dichroism of synthetic polypeptides in the α and β forms. The parallel dichroism in oriented specimens of poly-γ-benzyl-L-glutamate shows that the C=O and N—H bonds are directed along the chain axis rather than across it, and that the chains are folded. However, the dichroic ratio of the C=O frequency is much less than that of the N—H frequency. The significance of this finding for bond angles and distances in the structure was considered at length; one important point, brought out by W. C. Price, is that the dipole moment change in the C=O vibration may involve also the adjoining C—N linkage, on account of resonance in the amide group and of the 'orbital-following' effect. Hence, the infra-red dichroism may not give a correct indication of the orientation of the C=O bond. Studies on simple substances of known structure are needed; Elliott and his associates are now studying acetanilide, the crystal structure of which is partly but not yet fully known.

Sir Lawrence Bragg and Dr. Perutz presented their latest work on the structure of hæmoglobin; the study involves an attempt to determine a complete Fourier projection of the hæmoglobin molecule from a study of the *h0l* reflexions, using all the data

obtainable by varying the water and salt content of the crystals, and the chemical nature and species of the hæmoglobin. The pattern of the molecule should be resolvable within about 7 A. when the signs of all terms have been determined. Dr. C. H. Carlisle and Prof. J. D. Bernal discussed the crystal structure of ribonuclease. Dr. Carlisle discussed Patterson projections, inferring that parallel polypeptide chains appear to be present in the structure, but that these do not have the right packing and cross-section for α-helices. Prof. Bernal attacked the problem by a very different approach, selecting constellations of 'significant reflexions' as the starting-point for Fourier computations; the method does not lend itself to brief exposition and can only be mentioned here [see *Nature*, June 14, p. 1007].

Dr. K. Bailey reported his work[4] on the size and shape of the very asymmetric molecule, tropomyosin, which appears to be about 385 A. long, with an axial ratio about 22 : 1, and a molecular weight of 53,000. It contains no free α-amino group, and one free α-carboxyl. It is composed probably of two more-or-less parallel polypeptide chains.

H. E. Huxley reported low-angle X-ray studies on living muscle, which reveal the presence of very long molecules, packed in hexagonal array, and 450 A. apart. The relative intensities of the first- and second-order transverse reflexions from this spacing are completely reversed by removing adenosine triphosphate from the muscle. Along the fibre axis there is a repeating unit 420 A. in length; this seems to be due to the actin component, rather than to the myosin. Surprisingly, this spacing does not change on stretching the muscle. The axial and transverse patterns are still clearly observed in glycerol-extracted fibres (Szent-Györgyi's technique). This opens the possibility of studying contracted fibres by X-ray methods.

Although many topics were discussed at the meeting, the prime emphasis was on the underlying structural pattern of the polypeptide chains in proteins. As Dr. Corey remarked near the end, structures such as those proposed by Pauling are precisely defined; they lead to definite predictions about physical properties, and critics can attack these structures where they fail to fit the facts. Revised and improved models can then be put forward, and progress in this supremely important field should proceed with increasing rapidity.

JOHN T. EDSALL

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[2] Riley, D. P., and Arndt, U. W., *Nature*, **169**, 138 (1952).
[3] Low, B. W., *Nature* [**169**, 955 (1952)].
[4] Bailey, Tsao and Adair, *Biochem. J.*, **49**, 27 (1951).
[5] Yakel, Pauling and Corey, *Nature*, **169**, 920 (1952).
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KODAIKANAL OBSERVATORY

By DR. A. K. DAS
Director, Kodaikanal Observatory

THE Kodaikanal Observatory completed fifty years of astrophysical work in March 1951. The occasion was celebrated by a simple function held on September 18 over which His Highness Maharajah Sir Krishnakumarsinghji Bhavsinghji of Bhavnagar, Governor of Madras, presided, and a souvenir pamphlet describing the activities of the Observatory during the half-century was issued to commemorate the occasion.

Kodaikanal Observatory has its roots in the fairly distant past, for it is really the continuation of the Madras Observatory which was started in 1792 by the East India Company "for promoting the knowledge of astronomy, geography and navigation in India". Mr. N. R. Pogson, who was in charge of the Madras Observatory during 1861–91 and whose work in positional astronomy is well known, was the first astronomer to conceive the idea of establishing a branch of the Madras Observatory in the Palni or the Nilgiri Hills especially for photographic and spectroscopic observations of the sun and the stars. But it was in the time of Mr. Charles Michie Smith that the idea took practical shape, and a site at Kodaikanal (elevation 7,688 ft. above mean sea-level) in the Palni Hills was chosen for this branch. The foundation stone of the new Observatory at Kodaikanal was laid in 1895, and by 1901, when systematic solar observations were begun at Kodaikanal, the astronomical work of the Madras Observatory had almost completely ceased and practically all its equipment, except the historical meridian circle, had been transferred to Kodaikanal. However, the astronomical observatory at Madras still existed, though only in name; and Mr. Michie Smith's official designation was "Director of Kodaikanal and Madras Observatories", a designation which continued until 1932, when Kodaikanal Observatory's connexion with Madras came to an end.

Mr. John Evershed, who succeeded Mr. Michie Smith as director, joined the Kodaikanal Observatory in 1907 as assistant director. In 1909 he discovered the phenomenon of radial motion in sunspots which is commonly known as the Evershed effect. When Mr. Evershed became director in 1911, Dr. Thomas Royds joined as assistant director, and their fruitful collaboration continued until Mr. Evershed's retirement in 1922. A very considerable part of the accurate spectroscopic work for which this Observatory is noted was done during the period 1907–22. The tradition of high-dispersion spectroscopic work built up during this period has continued until the present day. But Dr. Royds, during his directorship, which lasted from 1922 until 1937, placed a good deal of emphasis also on the observational study of solar prominences and dark markings. Dr. A. L. Narayan, who was assistant director during 1928–37, succeeded Dr. Royds as director and remained in charge of the Observatory until about the middle of 1946. He was responsible for a considerable amount of work in atomic and molecular spectroscopy. Dr. A. K. Das, who as assistant director between 1937 and 1942 made theoretical studies of the motion of gases in the sun's atmosphere, returned to the Observatory after the Second World War and succeeded Dr. Narayan as director. Dr. R. Ananthakrishnan joined the Observatory as assistant director towards the end of 1946.

Since 1946 the spectroscopic equipment of the Observatory has been greatly improved by the construction of a number of high-dispersion spectrographs, siderostats, cœlostats, etc., and work on various problems of solar physics is in progress. It is expected that a 100-ft. solar spectrograph, a polarizing monochromator and a Lyot coronagraph will shortly be added to the equipment of the solar physics section. The most notable post-war developments in the activities of the Observatory have been, however, the addition of a magnetic and ionospheric branch and

of a section of stellar physics. The magnetic observatory, which was started towards the end of 1949, is now in full operation and is equipped with a set of Watson magnetographs, a set of La Cour magnetographs and the usual accessories; the equipment of the magnetic observatory will shortly be further strengthened by the addition of an Askania magnetic field balance, as well as a set of *QHM* and *BMZ* instruments. The principal instrument of the ionospheric observatory, which started functioning from the beginning of 1952, is an automatic multifrequency ionosphere recorder of the latest type designed by the U.S. Bureau of Standards. The magnetic and ionospheric section naturally has an electronics laboratory attached to it. Recently an equipment for the study of solar radio radiation in the 100 Mc./s. region has been built in the electronics laboratory and has been brought into regular use. Mr. B. N. Bhargava, who had his specialized training in radiophysics in the United States, is in charge of the magnetic and ionospheric section. The stellar physics section has made a modest beginning with a 20-in. Cassegrain reflector by Grubb as its principal instrument. Though old, it is an excellent and very versatile telescope which originally belonged to the now disused Observatory of Poona called after His Highness Maharajah Takhtasinghji of Bhavnagar. This telescope was presented to the Kodaikanal Observatory many years ago, but had remained unused and dismantled. Recently it has been installed for regular use after reconstructing several of its missing or damaged parts, and has been named the Bhavnagar telescope. Work on planetary spectra and some aspects of stellar spectroscopy is being begun with this instrument. Our plans for the development of the stellar physics section include the acquisition of a large Schmidt–Cassegrain telescope and a large reflector of about 100-in. aperture as soon as the necessary funds become available.

The developments that have already taken place have necessitated considerable improvements in our workshop facilities. The Observatory machine shop is now equipped for meeting most requirements of a modern astrophysical observatory; an optical workshop for the Observatory is also one of our projects.

PASTURE AND FODDER DEVELOPMENT IN MEDITERRANEAN COUNTRIES

THERE are a number of countries in the south of Europe and the north of Africa which have sufficient in common to be grouped as the Mediterranean area but in which there is also diversity of topography and, to some extent, of climate: the rainfall varies from 200 to 1,000 mm. a year. The prevalence of limestone rock with soils derived therefrom is a characteristic of this area; but there are considerable areas of igneous rocks, although here, too, practically all the overlying soils are directly related to these rocks. The olive and the evergreen oak are characteristics of the area; indeed, it may be said that a map of the olive and evergreen oak is a map of the typical Mediterranean area. The past history of these countries—invasions, wars and tribal movements—have necessarily affected the people's way of life and the agricultural traditions that have come to be established, but the influence of the past is not now easy to diagnose in its entirety.

There are some specialized crops, particularly the vine and the olive, that are long established and the management of which is generally good; but the cultivation of the more utilitarian crops is mostly unsatisfactory, and arable work on a rotational basis is very weak. Wheat is a dominant crop, and an alternation of wheat and fallow is the chief rotation.

Except in some parts of the south of France, there is a very great deal of pressure on the land to secure the livelihood of the people, and this arises to a considerable extent from the deterioration that has put some areas completely out of cultivation. There has in the past been a good deal of forest destruction, not only to make room for arable cultivation but also to provide wood for buildings and for ships; in consequence, there has been considerable denudation and erosion, and over-grazing has intensified this decline.

The keeping of small animals, particularly sheep and goats, is very common. The keeping of one or two animals by a family is quite normal, but there are also professional shepherds with their flocks. None of the stock, however, is developed for one primary purpose; almost every animal is a multiple-purpose animal to produce whatever labour, milk, meat, skin and so forth it can.

In addition to the defects in crop husbandry itself is the lack of integration between crop and animal husbandry. There is very little pasture specifically cultivated for grazing. Grazing is largely a random affair, and the stock graze in areas that are inaccessible for ploughing or on crop residues. The shepherds who keep flocks of sheep have little grazing ground which is their own, and these shepherds make financial arrangements wherever they can for their flocks to graze.

The Mediterranean farmer has for a long time followed tradition without receiving much inspiration for the development of new ideas, but it does seem that these people are amenable to help and guidance in raising the level of their farming. The pasture and forage problems are crucial to the progress that can be made, and in this connexion the Organization for European Economic Development has produced a report, entitled "Pasture and Fodder Development in Mediterranean Countries"*, which should be the means of big developments and considerable transformation. For some time now the Food and Agricultural Committee of the Organization has been concerned with the development of grassland in Europe, and, following a conference in Paris during May 1950, it published "Farm Advisory Methods for Grassland Improvement". It was during the Paris conference that the need for studying pasture and fodder production in the Mediterranean area was stressed and, in preparation for a conference on the matter, the countries concerned were surveyed by a number of experts from the United States, Australia, South Africa and Great Britain. Each of these experts worked with suitable colleagues in the country concerned, and reports on the various countries are published in Part 2 of the present publication of the Organization for European Economic Development. The reports were discussed first with representatives of the various countries and

* Pasture and Fodder Development in Mediterranean Countries. (Technical Assistance Mission No. 56.) Pp. 176. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1951.) n.p.

then at a conference in Rome in June 1951, when a number of important recommendations were agreed.

A fundamental consideration in pasture and forage development is necessarily the climate and its effect on the growing season. Information about climatic conditions is essential if experience in one area is to be helpful in another, and if the introduction of plants from one region to another is to be carried out rationally. It was therefore recommended in the report that studies of climate and the keeping of reliable meteorological records must be undertaken, and suggestions for the minimum necessary undertakings are made.

A few of the indigenous plants in these countries have been developed commercially; but for the most part they have not been systematically studied and assessed, although this is work that provides essential data for pasture improvement and, as the report points out, can be effective in a very short time. The conference also urged that each country should, in due course, introduce and test species and strains from other countries, and that a systematic programme of seed production should be made possible.

Following systematic study in a country of plants involved in pastures, the integration of pastures and fodder for grazing with its whole scheme of arable farming must be studied and developed. It is suggested that a first step in this matter might be the incorporation of an annual fodder crop into the familiar cereal/fallow rotation, and that, where the climate permits, the fallow be replaced by an appropriate legume, so that in due course this might be developed into a wheat/legume/legume rotation, with wheat every third year, or, in the drier parts, the rotation might be wheat/legume/fallow. The lengthening of rotations in this way should, where it is possible, bring in grazing animals. This will admittedly be difficult in some areas of small holdings where there is no communal grazing, but it is a programme to be aimed at. Moreover, at the present time animal production is very much affected by seasonal food production, and an appropriate development of the continuous production of fodder all the year round is a vital matter.

There are many other lines of work suggested for the improvement of pasture and forage; but the conference has not been unmindful of important economic aspects. Improvements in production will be justified only when and where there are appropriate markets, and in some cases potential markets will need development. The need for increasing the consumption of milk in these countries is one important matter in this connexion. Better farm implements are required; and it is realized, too, that there must be a development in the use of fertilizers (at present much of the land is very poor, particularly in phosphate and nitrogen), and a definite price policy in the development of fertilizers will be required. The need for credit facilities also received the attention of the conference.

The conference expressed the hope that the interest of pasture and fodder developments in the Mediterranean countries will justify the establishment of research stations and pilot farms, and also of a journal and a Mediterranean grassland committee.

A number of technical papers bearing on the subject of the conference were read at the Rome meeting and are produced in Part 3 of the report.

N. M. COMBER

NEWS and VIEWS

Directorship of the Lister Institute: Sir Alan Drury, C.B.E., F.R.S.

THE retirement is announced of Sir Alan Drury from the directorship of the Lister Institute, London, which he has held since 1943. Sir Alan assumed the directorship at a difficult period in the history of the Institute, the work of which had been much disorganized by the War. He brought to his task not only his outstanding personal qualities of patience and quiet efficiency, but also a wide knowledge of many aspects of medical research which he had acquired through long service on the scientific staff of the Medical Research Council. His experience included clinical research with the late Sir Thomas Lewis, many years of distinguished work in experimental pathology at Cambridge and a period of most valuable service during the War in the Council's headquarters office. Under Sir Alan's guidance, the Lister Institute has been restored to its position as a centre of active medical research, sustaining its earlier reputation for work in immunochemistry and becoming well known for investigations of blood groups and blood products; it has also taken on new and important responsibilities in connexion with the preparation of sera and vaccines. During his directorship Sir Alan has served as a member of the Medical and the Agricultural Research Council, and both bodies owe much to his help and advice. It is inevitable that the many administrative burdens which Sir Alan has had to shoulder should have greatly restricted his opportunities for personal research at the Lister Institute. It is good, therefore, to know that after his retirement such opportunities will be restored to him when he takes up his work in the Agricultural Research Council's Institute of Animal Physiology. Sir Alan's personal qualities and scientific attainments ensure that the research in experimental pathology which is to be under his care in this Institute will develop on sound lines.

Dr. A. A. Miles

DR. A. A. MILES, who is to succeed Sir Alan Drury as director of the Lister Institute, has been, since 1946, director of the Division of Biological Standards at the National Institute for Medical Research; for the past five years he has also been deputy director of the Institute. Before his appointment to the scientific staff of the Medical Research Council, Dr. Miles had become recognized as one of the leading bacteriologists in Great Britain. He had had fruitful periods of work at the London School of Hygiene, at Cambridge, at the Postgraduate Medical School in London, and as professor of bacteriology at University College Hospital Medical School, London, where he showed himself to be an outstandingly successful teacher. During his tenure of the latter appointment he had, throughout the War, the responsible position of sector pathologist within the Emergency Medical Service. As director of the Division of Biological Standards at the National Institute for Medical Research, Dr. Miles has had the task of continuing

and developing the work so admirably built up by Sir Percival Hartley. The international appreciation which his efforts have met with is shown by his election as chairman of the Expert Committee on Biological Standardization of the World Health Organization. Dr. Miles has not allowed his official duties to diminish his enthusiasm for investigation. He has been throughout, and he continues to be, an active research worker, being best known for his immunological studies of *Brucella* and, more recently, for his investigation of factors affecting the spread of infection within the animal body. In him the Lister Institute acquires a director of wide knowledge and experience, under whose energetic leadership research work will have every encouragement.

Bacteriology in Leeds: Prof. J. W. McLeod, O.B.E., F.R.S.

James Walter McLeod, who is retiring from the Brotherton chair of bacteriology in the University of Leeds, has profoundly influenced the development of his subject during the past thirty years. Born in January 1887, he received his early education at George Watson's College, Edinburgh, in Lausanne, and at Mill Hill School, and entered the University of Glasgow in 1903, graduating M.B., Ch.B. in 1908. He showed early that his interests lay in laboratory medicine, and, after a year of clinical training in the wards of John Cowan and Sir Kennedy Dalziel, he commenced research in bacteriology with Sir Robert Muir, and was appointed lecturer in pathology at Charing Cross Hospital, London, in 1909; during the First World War he served with distinction—mentioned in dispatches four times and awarded the O.B.E.—in the R.A.M.C. as officer commanding a mobile laboratory. On demobilization McLeod was appointed lecturer in bacteriology at the University of Leeds and became the first incumbent of the Brotherton chair in 1922. During thirty years his contributions to the subject of bacteriology have been notable for their quality and diversity: the pathogenicity of streptococci, the problems of bacterial nutrition and respiration, study of the anaerobes, of the gonococcus, of diphtheria (both as a problem of bacteriology and of epidemiology), have among many other subjects claimed his attention, and in no instance have his findings failed to stand the test of time. Combining the outlook of a general biologist with the exactitude of a physicist and the humanity of a physician, it was but natural that the most notable influence which his work has exerted has been to integrate the study of bacteriology as a subject *per se* with its application to medicine. The honours which he has so rightly deserved—fellowship of the Royal Society, honorary D.Sc. of the University of Dublin, presidency of the Society of General Microbiology—have been a source of very real pleasure to all who know him, and his friends wish him every happiness in his retirement.

Dr. C. L. Oakley

Dr. Cyril Leslie Oakley, who succeeds Prof. McLeod, was born in 1907 and graduated in medicine from University College, London, in 1930, taking a first-class honours B.Sc. in zoology at the same time; three years later he took his M.D. in pathology. After three years as Graham Scholar at the University College Hospital Medical School, he was appointed experimental pathologist at the Wellcome Research Laboratories, Beckenham, in 1934, becoming head of the Immunology and Experimental Pathology Department in 1947. He was elected a Fellow of University College, London, in 1950. During the Second World War he was responsible for the organization of a subsidiary unit of the Laboratories, at Carshalton, where part of the very large production of antitoxin and prophylactics for the Army was carried on. While a Graham Scholar, Dr. Oakley worked on the rate of regeneration of red cells after repeated bleedings. In his first years at Beckenham, besides being responsible for all the morbid histology work of the Laboratories, he worked on virus diseases, particularly influenza, setting up his own unit for making Elford membranes. He then became interested in the pathogenic *Clostridia* and, with his collaborator, Dr. G. H. Warrack, added greatly to the knowledge of the complex antigenic constitution of this group, discovering a number of new toxins and enzymes. He has of recent years, by the use of an ingenious method of immunization with two toxoids simultaneously, furthered very considerably our knowledge of the site of origin of antitoxin. One of the most remarkable observations in this work was the demonstration that aluminium hydroxide adsorbs tetanus or diphtheria toxoid when injected into omental or perirenal fat, and leads to a local production of antitoxin. Dr. Oakley has never abandoned his early zoological interest, and one of his hobbies has been a serious research into the anatomy and systematics of parasitic copepods.

University of Aberdeen

The honorary degree of LL.D. of the University of Aberdeen has been conferred on the following, among others: Prof. Niels Bohr, professor of theoretical physics, University of Copenhagen; Prof. H. Butterfield, professor of modern history in the University of Cambridge since 1944; Prof. James Ritchie, professor of natural history in the University of Edinburgh since 1936; Prof. H. E. Shortt, professor of medical protozoology in the University of London and head of the Department of Parasitology in the London School of Hygiene and Tropical Medicine; and Prof. David Landsborough Thomson, professor of biochemistry in McGill University, Montreal, since 1937.

Medicine and the Mind

For his Rede Lecture, given to the University of Cambridge this year and now published (pp. 30; Cambridge: At the University Press, 1952; 2*s.* 6*d.* net), Sir Russell Brain, president of the Royal College of Physicians, chose as his subject "The Contribution of Medicine to Our Idea of the Mind". Sir Russell pointed out that from an early stage of his training the medical practitioner is made aware of the intimate relationship between the body and the mind, that is, he is always dealing with a body–mind unity, though his chief concern may be with one or the other. The great advances in neurophysiology, neurology and psychiatry during the present century have given us a much more detailed knowledge, enabling us to correlate brain disturbance with mental changes. Disease has made a great contribution to our knowledge of the normal brain–mind relationship, and research has been facilitated by the use of the electro-encephalograph, a machine for amplifying and recording the minute electrical brain-rhythms. It is now known that certain people who behave abnormally have abnormal brain rhythms. Independently of the work of the neuro-physiologists and neuro-psychiatrists, a school of psychological thought

has developed which seeks to give a psychological explanation of many forms of mental abnormality, and again the abnormal has thrown light on the normal. The pioneer work of Freud in this field, continued Sir Russell, has been as revolutionary in the interpretation of the mind as was the work of Darwin in the interpretation of the body. Freud did not discover the unconscious mind, for many thinkers deduced it from a study of human thought and behaviour; but he developed the idea practically and produced evidence to show that experiences involving strong emotions might continue to influence behaviour though they had been forgotten, and that feelings such as anxiety might persist divorced from the original ideas. Certain philosophical questions are involved; for example, why is consciousness necessary at all, and why is it associated with some functions of the brain and not with others? The recent contribution of medicine to our ideas of the mind have been, like most of modern science, analytical. But, as Sir Russell emphasized, medicine is also an art, and as an art must realize that the whole man is more than the sum total of parts. It is necessary, more than ever, to find a way of harmonizing logic, philosophy and humanity.

FAO MEMO: New Leaflet of the United Nations Food and Agriculture Organization

THE accounts of the activities of the Food and Agriculture Organization of the United Nations, available as yearbooks and other official publications, are often beyond the scope of the non-technical reader, who nevertheless is interested in the practical steps being taken to overcome hunger and raise the standard of living in various parts of the world. To meet the need of this section of the public, the Organization has started a new illustrated leaflet, *FAO MEMO*, which gives, in semi-popular form, short authentic accounts of its very varied work. In the first issue, which appeared in March, one learns of the success of the publicity campaign in Santiago for encouraging the production and consumption of fish, and in the following number of the project for turning the Jizan region of Saudi Arabia, liable to disastrous extremes of drought and flood, into a flourishing agricultural district by controlling the water supply. Accounts are also given of the useful work being done in the development of rural community life in the Pátzcuaro Lake region of Mexico, and of some occasions, notably that of the recent hurricane in Jamaica, when valuable technical assistance was provided. The *MEMO* is published monthly by the Informational and Educational Services in Rome of the Food and Agriculture Organization, and by the Regional Information Offices in Bangkok, Cairo, New Delhi, Mexico City, and Washington, D.C. Copies of the European edition can be obtained from the Documents Service, Food and Agriculture Organization, Viale delle Terme di Caracalla, Rome, and of the other editions from the appropriate regional offices.

Food and Agriculture Organization: David Lubin Memorial Library

AT a formal ceremony on June 10 the library of the Food and Agriculture Organization of the United Nations was inaugurated in Rome by the director-general, Norris E. Dodd, in the presence of the Council of the Organization, the American Ambassador to Italy, the Italian Minister of Agriculture and representatives of members of the Food and Agriculture Organization. The children and the secretary of David Lubin, founder of the Institut International de l'Agriculture and of its library of some 350,000 publications, which now forms the most substantial and important part of the Food and Agriculture Organization's library of some 400,000 works were among the guests at the opening ceremony. Housed in the modern building generously made available by the Italian Government, the library contains reading rooms, reference, photostat, microfilm services and eighteen kilometres of shelves. In opening it to the public, Mr. Dodd said, "It is a living resource for the service of the world's agriculture. We wish to make it as open as possible to all scholars and technicians and research workers".

Scientific and Technical Periodicals Published in East Asia

THE East Asia Science Co-operation Office, Manila, has issued a list, compiled in 1950, of scientific and technical periodicals published in South-East Asia. The periodicals are listed separately under the Philippines, Indonesia, Malaya, Thailand, Indo-China and Hong Kong, but for each country they are arranged in fourteen broad categories and are also entered in an index by categories covering all six countries. The list covers 142 periodicals and includes particulars of publishers and rates of subscriptions. There is, in addition, an alphabetical index to periodicals arranged under countries. The Office has also issued a supplement to the list, which gives details of some 119 Chinese periodicals. This was compiled in the Shanghai bureau of the Office at the end of 1950 and was revised in the summer of 1951. The supplement is considered incomplete, especially for periodicals published outside Shanghai. Titles are listed alphabetically and also classified by subjects, and particulars of publishers, language, frequency, subscription and commencement of publication are included. The co-operation of scientific workers and librarians in repairing omissions and correcting errors in the list as a whole is invited.

British Thomson-Houston Engineering Research Fellowships

THE British Thomson-Houston Co., Ltd., has instituted the award (annually) of engineering research fellowships. The award is open to honours graduates who are in their last year of apprenticeship with the Company. The holder of a fellowship will engage in engineering research for a limited period (one to three years) either wholly within the Company or partly within the Company and partly at a university. He will work under the supervision of a senior engineer of the Company and under the guidance of a Research Fellowship Panel set up for the purpose. The Director of Research and Education is chairman of the Panel, which includes other senior executives of the Company and, in addition, Prof. E. B. Moullin and Prof. Willis Jackson. This year (1952) fellowships have been awarded to P. H. G. Allen and P. C. McNeill. Mr. Allen was educated at King Edward VI Grammar School, and the City College, Norwich. During the War he served with the Royal Engineers and was a prisoner-of-war in Japan for three and a half years. On demobilization, he studied at King's College, London, and obtained his degree in electrical engineering with first-class honours in 1950. His research will be concerned with heat flow in large transformers. Mr. McNeill was educated at Loretto School, Midlothian. During the

War he served with R.E.M.E. and was demobilized in 1947 with the rank of captain. He then studied at Queen's University, Belfast, and graduated with first-class honours both in electrical and in mechanical engineering in 1950. His research will be on the secondary emission coefficients in magnetrons.

Ramsay Memorial Fellowships

The Ramsay Memorial Fellowships Trustees have made the following awards of new fellowships in chemistry for 1952–53: Mr. D. Clark, a British Fellowship of £500 a year at the University of Birmingham; Mr. R. F. Webb, a British Fellowship of £500 a year at the University of Cambridge; Dr. G. S. Trick, a Canadian Fellowship at King's College, London; Mr. Juan Llopis Mari, a Spanish Fellowship at King's College, London; Mr. R. O. Steiner, a Swiss Fellowship at the Imperial College of Science and Technology, London; Mr. David R. Lide, a United States Fellowship at the University of Oxford. The Trustees have renewed the following fellowships for the same year: Mr. L. E. Lyons (British Fellowship) at University College, London; Mr. James Jack (Glasgow Fellowship) at the University of Cambridge; Dr. Serafin Novoa (Spanish Fellowship) at the University of Oxford.

Botanical Society of Bengal: Annual General Meeting and Officers

The annual general meeting of the Botanical Society of Bengal was held on April 27 at the Botany Laboratory, Presidency College, Calcutta. Dr. J. C. Sen Gupta, principal of the College, who is also the president of the Society, pointed out in his address that the physiology of plants with which we are at present familiar is a physiology of the plants of the temperate climate of Europe and North America, and he stressed the importance of a thorough research on the physiology of tropical plants. This will also help in future plans for research on improvement of agricultural crops, medicinal plants and other plants of economic importance. He also laid stress on the need for enlarging the scope of study in plant physiology at Indian universities and pointed out the great importance of taking necessary steps for the establishment of an institute of plant physiology in or near Calcutta. The chief guest at the meeting, H.E. Dr. H. C. Mookerjee, spoke on the need of research for the betterment of crop yields and the introduction and synthesis of new fruits, etc.; he also emphasized that there should be more members of the Society, and all of them should undertake co-ordinated research. The following officers of the Society were elected: *President*, Dr. J. C. Sen Gupta; *Vice-Presidents*, Dr. K. P. Biswas and Prof. P. C. Sarbadhikari; *Secretary for Foreign Correspondence*, Sri A. K. Ghosh; *Councillors*, Dr. H. K. Nandi, Dr. S. M. Sircar, Dr. P. N. Bhaduri, Dr. H. L. Chakravorty, Dr. B. K. Kar, Prof. B. K. Mitra and Dr. P. N. Nandi; *Editor of Publications*, Prof. S. R. Bose; *Honorary Secretary*, Dr. N. K. Sen (35 Ballygunge Road, Calcutta 19); *Honorary Treasurer*, Sri P. K. Bose; and *Honorary Librarian*, J. Sen.

Symposium on Combustion

An international symposium on combustion is to be held at the Massachusetts Institute of Technology during September 1–5. It is expected that about a hundred papers will be presented, from Great Britain, France, Holland, Belgium, Germany, Japan and the United States. Emphasis is being placed on the physical aspects of combustion, particularly wave phenomena and turbulence, treated from both the experimental and theoretical points of view. The complete papers will appear later in a single volume, like that issued after a similar symposium held in 1948. Further information can be obtained from the Summer Session Office, Combustion Symposium Committee, Massachusetts Institute of Technology, Cambridge 39, Massachusetts, or from Prof. Hoyt C. Hottel, professor of fuel engineering at the Institute, who is co-chairman of the symposium.

Forthcoming Congresses associated with International Scientific Unions

The following meetings associated with international scientific unions are taking place in the next few months: the Royal Society, through its British national committees, is the adhering body for Britain to each of the unions, and available information of these congresses may be obtained from the Assistant Secretary of the Royal Society (Burlington House, Piccadilly, London, W.1). *Astronomy:* Eighth General Assembly of the International Astronomical Union (Rome, September 4–13); *Geography:* Eighth General Assembly of the International Geographical Union (Washington, August 8–15, to coincide with the seventeenth International Geographical Congress); *Theoretical and Applied Mechanics:* Third General Assembly of the International Union of Theoretical and Applied Mechanics (Istanbul, August 20–28, to coincide with the seventh International Congress of Applied Mechanics); *Scientific Radio:* Tenth General Assembly of the International Union of Scientific Radio (Sydney, August 11–23); *Analytical Chemistry:* First International Congress on Analytical Chemistry (Oxford, September 4–9); meetings of the Analytical Chemistry Section of the International Union of Pure and Applied Chemistry will take place during the period of the Congress; *International Council of Scientific Unions:* Sixth General Assembly of the International Council of Scientific Unions (Amsterdam, October 1–3).

University of London

Dr. F. L. Warren, reader in biochemistry in University College, has been appointed to the University chair of biochemistry tenable at London Hospital Medical College. Dr. Eric Neil, senior lecturer in physiology in Middlesex Hospital Medical School, has been appointed to the University readership in physiology tenable at Middlesex Hospital Medical School. Dr. W. S. Bullough, honorary lecturer in the University of Sheffield, has been appointed to the University chair of zoology tenable at Birkbeck College.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: R. B. Allnutt (director of agriculture, Leeward Islands), assistant director of agriculture, Nigeria; R. Aribisala, J. A. Carter, R. F. S. Hainsworth, D. R. E. Jackson, J. O. I. Longe, R. Miller and P. Mulholland (agricultural superintendents, Nigeria), agricultural officers, Nigeria; E. J. Gregory (senior agricultural officer, Jamaica), deputy director of agriculture, Jamaica; R. B. Jagoe (senior botanist (time scale), Federation of Malaya), senior botanist (superscale), Federation of Malaya; G. B. Kennard (marketing officer, British Guiana), senior field officer, British Guiana; E. W. Leach (director of agriculture, Trinidad), director of

agriculture, Gold Coast; E. W. Momber (senior agricultural officer, Nigeria), principal agricultural officer, Nigeria; J. T. Moon (senior agricultural officer, Kenya), assistant director of agriculture, Uganda; B. A. O'Connor (entomologist, Fiji), senior entomologist, Fiji; H. T. Pagdon (senior entomologist (time scale), Federation of Malaya), senior entomologist (superscale), Federation of Malaya; M. M. Lucie Smith (agronomist, Trinidad), assistant director of agriculture, Gold Coast; I. R. Dale (senior assistant conservator of forests, Uganda), deputy conservator of forests, Uganda; L. R. Hutson (chief veterinary officer, Antigua, Leeward Islands), deputy director of agriculture (animal husbandry), Trinidad; H. K. Littlewood (deputy director of veterinary services, Nigeria), principal veterinary officer, Western Region, Nigeria; J. McCulloch (senior veterinary officer, Nigeria), principal veterinary officer, Eastern Region, Nigeria; J. K. H. Wilde (chief veterinary research officer, Tanganyika), assistant director of laboratory services, Nigeria; E. Buckley (assistant principal, Technical College, Kuala Lumpur), principal, Technical College, Kuala Lumpur; C. J. Morrison (supervisor grade 2, Agricultural Society, Jamaica), senior soil conservation officer, Jamaica; T. J. Taverner (agricultural assistant, Tanganyika), superintendent of agriculture, Tanganyika; G. W. Arnott, agricultural chemist, Federation of Malaya; P. Class, T. R. Dickinson and D. M. Fordyce, agricultural officers, Federation of Malaya; A. R. Dunbar and W. Hadlow, agricultural officers, Uganda; C. R. Dunton, agricultural officer, Aden; D. F. Edwards and F. Miller, agricultural officers, Gold Coast; R. T. Ellis, plant breeder, Nyasaland; J. T. Hall, agricultural officer, Northern Rhodesia; Miss M. Hayward, plant pathologist, Nyasaland; N. B. Joy, plant pathologist, Tanganyika; A. K. Murray, agricultural officer, Sierra Leone; E. L. Neil, agricultural officer, Nigeria; W. P. Panton, soil chemist (geologist), Federation of Malaya; C. W. R. Pearse, agricultural officer, Tanganyika; S. A. Elks, chemist, Federation of Malaya; E. R. W. Fogden, chemist, Tanganyika; J. A. G. Ellis, assistant conservator of forests, Gold Coast; O. Kerfoot, assistant conservator of forests, Northern Rhodesia; J. F. Watson, assistant conservator of forests, Federation of Malaya; D. A. Eaton, agricultural cocoa survey officer, Gold Coast; G. English, geologist, Nigeria; T. Gorazdowski, fisheries officer, Hong Kong; K. Marshall, prehistorian, Geological Survey Department, Uganda; Miss J. Redwood, assistant adviser on aborigines, Federation of Malaya; D. J. Watson, fisheries officer, Tanganyika.

Announcements

DR. E. B. CHAIN, professor of biochemistry and director of the International Research Centre for Chemical Microbiology, Rome, has been elected a foreign correspondent of the Paris Academy of Medicine.

THE Dr. W. S. Bruce Memorial Prize for 1952 of the Royal Society of Edinburgh has been awarded by the Joint Committee of the Royal Physical Society, the Royal Scottish Geographical Society, and the Royal Society of Edinburgh, to G. de Q. Robin, for his initiative and resource in carrying out glaciological and biological researches in the Antarctic while with the Falkland Islands Dependencies Survey (1946–47) and with the Norwegian–British–Swedish Expedition (1950–51).

THE Secretary of State for War has appointed Mr. H. A. Sargeaunt to be scientific adviser to the Army Council with effect from July 1. Mr. Sargeaunt has held the appointment of deputy scientific adviser to the Army Council since April 1950, and was previously the superintendent of the Army Operational Research Group.

DURING the recent European Congress for Chemical Engineering, in Frankfurt am Main, the Council, representing seventeen countries, decided to make the congress a permanent annual feature. At the Council's meeting on May 20, a standing committee of four members was elected as follows: Dr. Francis A. Freeth (United Kingdom), M. Jean Gérard (vice-president, Société de Chimie Industrielle, France), Dr. Luigi Morandi, president (Italy), Dr. Herbert Bretschneider, vice-president of the Dechema (Deutsche Gesellschaft für chemisches Apparatewesen, E.V.), Frankfurt am Main. The next European Congress will take place during June 1953 in Paris.

THE twenty-seventh annual conference of Aslib will be held at The Hayes, Swanwick, Derbyshire, during September 19–22, under the chairmanship of Sir Stephen Tallents. The opening address will be given by Prof. T. U. Matthew, professor of the principles of engineering production in the University of Birmingham, who will speak on "The Significance of Information in Present-day Industrial Society". Further information can be obtained from Aslib, 4 Palace Gate, London, W.8.

A MEETING was held in the rooms of the Royal Entomological Society of London on March 12, at which, in response to a request from Prof. Grassé and others, the proposal to form a British branch of the Union Internationale pour l'Étude des Insectes Sociaux was discussed. Dr. J. D. Carthy, of Queen Mary College, Mile End Road, London, E.1, has agreed to act provisionally as secretary, and would be glad to hear from any British biologist who would like to join such an organization. If the necessary response is received, steps will be taken to put the organization on a permanent basis and to nominate officers.

A STUDENTS' essay prize for 1952 has been awarded by the Council of the Institute of Metals to Mr. John C. Wright, of the Development and Research Department, Mond Nickel Co., Ltd., Birmingham, for an essay on "The Metallographic Investigation of Failed High-Temperature Components". In 1953, the Council will award two students' essay prizes of twenty guineas each. The competition is open to student members of the Institute and to associate members of local sections who are eligible for student membership of the Institute, and between the ages of seventeen and twenty-five. The choice of subject is left to the competitors, except that subjects relating exclusively to extraction and ferrous metallurgy are excluded. Entry must reach the Secretary, Institute of Metals, 4 Grosvenor Gardens, London, S.W.1, not later than January 1, 1953.

ERRATUM. In *Nature* of June 21, p. 1042, in the article on "A Diffraction Corona near the Centre of the Spiral Nebula NGC 4216", by Prof. Bertil Lindblad and Aina Elvius, the blocks for Figs. 3 and 4 have been inadvertently interchanged. The legends are correct as printed.

COSMIC RAYS AND THE SUN'S MAGNETIC FIELD

Apparent Absence of Low-energy Cosmic-ray Primaries

THE purpose of this communication is to examine critically present evidence on the intensity of cosmic rays above and near the top of the atmosphere at high latitudes. It is concluded that low-energy primaries are absent to a significant extent, and that there exists, therefore, near a geomagnetic latitude of 58°, a flattening of the primary momentum spectrum, commonly referred to as a 'knee'.

(*a*) Rocket measurements[1] above the atmosphere at geomagnetic latitude (λ) 58° N. (Gulf of Alaska) yielded a total directional intensity of charged particles of $0{\cdot}29 \pm 0{\cdot}03$ sec.$^{-1}$ cm.$^{-2}$ steradian^{-1} in the vertical direction. The amount of material in the Geiger tube telescope system was 3 gm./cm.^{2} of copper and 0·7 gm./cm.^{2} of aluminium—thus excluding protons[2] of kinetic energy less than 60 MeV. However, the minimum magnetic rigidity of a charged particle for arrival at 58° N. and zenith angle zero is $pc/Ze = 1{\cdot}17 \times 10^9$ V., which corresponds to a kinetic energy of 560 MeV. for protons[3]. Thus, the measured intensity presumably corresponds to the intensity of primary protons (see paragraphs (*f*) and (*g*)) of energy greater than 560 MeV., where the term 'primary' is taken to refer to radiation in the general vicinity of the earth's orbit.

(*b*) Balloon measurements of a similar nature by Pomerantz[4] near the top of the atmosphere at $\lambda = 69°$ N. (Fort Churchill, Canada) gave a vertical intensity of $0{\cdot}25 \pm 0{\cdot}02$ sec.$^{-1}$ cm.$^{-2}$ steradian^{-1}, a value slightly less than, but within the combination of experimental uncertainties closely equal to, the rocket measurements of ref. 1. However, in the measurements of Pomerantz, the low-energy limit is due to absorption of the residual atmosphere above the apparatus and of the apparatus itself. This may be seen as follows. The magnetic rigidity cut-off at 69° N. and zenith angle zero is $pc/Ze = 0{\cdot}25 \times 10^9$ V., or a proton kinetic energy of 32 MeV. But the residual atmosphere and the balloon-borne telescope totalled about 16 gm./cm.^{2} of air, glass and copper, an amount of material sufficient to stop 130-MeV. protons (cf. table).

Geomagnetic latitude	58°	69°
Measured flux (part. cm.$^{-2}$ sec.$^{-1}$ ster.$^{-1}$)	$0{\cdot}29 \pm 0{\cdot}03$	$0{\cdot}25 \pm 0{\cdot}02$
Min. magnetic rigidity in vertical direction	$1{\cdot}17 \times 10^9$ V.	$0{\cdot}25 \times 10^9$ V.
Corresp. kinetic energy : proton	560 MeV.	32 MeV.
α-particle	670 MeV.	32 MeV.
Instrumental and atmospheric absorption		
Rocket experiment	3·7 gm./cm.^{2}	
Balloon experiment		16 gm./cm.^{2}
Lowest accepted energy (if permitted by geomagnetic field)		
Rocket experiment : proton	60 MeV.	
α-particle	240 MeV.	
Balloon experiment : proton		130 MeV.
α-particle		520 MeV.

(*c*) Thus, from (*a*) and (*b*), it appears that there is a negligible intensity of primary protons in the energy-range 130–560 MeV.—certainly a far lower intensity than would be obtained by extrapolation of the primary spectrum as obtained experimentally in the rigidity range $2{\cdot}6 \times 10^9$–15×10^9 volts[1,5].

(*d*) It may also be noted that the total absorbing material in Pomerantz's experiment, 16 gm./cm.^{2}, is only about one-fourth of the mean free path for nuclear interaction, making the extreme assumption of geometrical cross-section. The attenuation of primaries by processes other than ionization should be small. Thus conclusion (*c*) is not essentially affected by these considerations.

The energy-range of conclusion (*c*) is relatively insensitive to inaccuracies in knowledge of the residual pressure at the maximum balloon altitude. For example, if the minimum residual atmosphere were as great as 20 gm./cm.^{2} instead of the reported value of 11 gm./cm.^{2}, the range of energy would be reduced only slightly, to 170–560 MeV.

(*e*) The above does not exclude, but does tend to make unreasonable, a large intensity of primary protons of energies less than 130 MeV.

(*f*) Various observers[6] have reported that the primary radiation contains 15–35 per cent of alpha-particles. It is therefore of importance to apply similar considerations to these. For alpha-particles, the geomagnetic cut-off kinetic energies corresponding to the previously mentioned magnetic rigidities are 670 MeV. and 32 MeV. at geomagnetic latitudes 58° and 69°, respectively. The rocket apparatus at 58° would exclude alpha-particles of energy less than 240 MeV., and the balloon apparatus and residual atmosphere at 69° would exclude alpha-particles of energy less than 520 MeV. (cf. table).

Thus, it appears that there is a negligible intensity of primary alpha-particles in the energy-range 520–670 MeV. In view of the lower absolute intensity of alpha particles, the narrowness of the deduced energy-range, and possible uncertainties in the balloon altitude, this result is less conclusive than that for protons.

(*g*) Due to the short range of low-energy primary nuclei of Z greater than 2, and their low intensity, the present considerations are of no significance in the determination of a possible 'knee' in their spectra.

The conclusions of this note are in agreement with those of Carmichael and Dymond[7]; but they are perhaps more definitive. We are, however, unable to support the conclusion of Pomerantz[4] that there is no sharp low-energy cut-off in the primary spectrum. Nor can we agree—using the same conventional argument—that the cosmic-ray evidence places as low an upper limit on the sun's magnetic moment as $0{\cdot}6 \times 10^{33}$ gauss-cm.^{3}. The essence of the disagreement is the fact that our measurement of primary intensity at latitude 58° shows that the whole of the increase of intensity observed by Pomerantz between 52° and 69° has already occurred at 58° (see spectral plot in ref. 1). Therefore, the knee of the integral-number spectrum of the primary radiation occurs south of 58° and not north of 69°.

Contradictory evidence has been reported by Staker, Pavalov and Korff[8], indicating an increase at all altitudes by a factor of 2 in the neutron intensity at 69° as compared with 54·7°; however, the extensive neutron measurements made by aircraft by Simpson[9] show practically no increase between the same two latitudes at 30,000 ft. when measured within a short time interval, thus giving support to

our conclusions. In fact, recent measurements[10] on the time dependence of the intensity of the nucleonic component lead to an attitude of restraint in the interpretation of intensity differences of the order of 10 per cent, unless measurements are made simultaneously or are normalized by means of an appropriate, continuously operating monitor instrument.

In order to clarify the cause of the 'knee' and in particular to decide between the hypothesis of a solar magnetic field and an inherent change in the form of the primary spectrum due to the mechanism of generation or propagation of cosmic rays, the present measurements should be extended to answer the questions :

(i) Is there complete absence of low-energy primaries at all times ? In other words, does the slope of the primary spectrum beyond the 'knee' become zero, or merely very close to zero ?

(ii) Do primary alpha-particles and heavier components of the primary radiation exhibit a low-energy cut-off corresponding to the same magnetic rigidity as the proton cut-off ($\sim 1{\cdot}5 \times 10^9$ V.) ?

Suitable apparatus which will admit protons of energies down to 5 MeV. is available, but because of the great practical difficulty of getting balloons above a pressure of 10 gm./cm.^{2} it is likely that further extension of the empirical primary spectrum to lower energies can best be done by rocket flights above the atmosphere at northerly latitudes.

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Jan. 10.

[1] Van Allen, J. A., and Singer, S. F., *Phys. Rev.*, **78**, 819 (1950); **80**, 116 (1950).
[2] Smith, J. H., *Phys. Rev.*, **71**, 32 (1947).
[3] See Alpher, R. A., *J. Geophys. Res.*, **55**, 437 (1950), for a summary of geomagnetic theory in a form suited to the needs of the experimentalist.
[4] Pomerantz, M. A., *Phys. Rev.*, **77**, 830 (1950).
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[6] Ney, E. P., and Thon, D. M., *Phys. Rev.*, **81**, 1069 (1951), and references therein.
[7] Carmichael, H., and Dymond, E. G., *Proc. Roy. Soc.*, A, **171**, 321 (1939).
[8] Staker, W. P., Pavalov, M., and Korff, S. A., *Phys. Rev.*, **81**, 889 (1951).
[9] Simpson, jun., J. A., *Phys. Rev.*, **81**, 639 (1951); **83**, 1175 (1951).
[10] Simpson, J. A., Fonger, W., and Wilcox, L., *Bull. Amer. Phys. Soc.*, **26**, 24 (1951), and private communication.

Diurnal Variation of Cosmic Rays and the Sun's Magnetic Field

If the latitude cut-off described in the preceding communication is indeed due to a solar magnetic field, then the value of the solar magnetic dipole moment would be $0{\cdot}65 \times 10^{34}$ gauss-cm.^{3}. (This dipole moment can be expressed as $8{\cdot}75 \times 10^9$ V. $\times$ (sun–earth distance)[2] and corresponds to an empirically observed[1] proton cut-off momentum at the earth's orbit of $1{\cdot}5 \times 10^9$ eV./c.) In addition, such a magnetic dipole field is expected to lead to a diurnal variation[1] of the low-energy part of the primary cosmic radiation incident on the earth. (In particular, the allowed solar cone would be completely open for particles of magnetic rigidity of $8{\cdot}75 \times 10^9$ V. and completely closed for particles of $1{\cdot}5 \times 10^9$ V. ($= (1 + 2^{1/2})^{-2} \times 8{\cdot}75 \times 10^9$ V.) according to the Störmer theory of the allowed cone.) The experimental absence[2] of this diurnal variation has been used for supporting the view that the sun's field must be at least an order of magnitude smaller than the value given above. (This would then be in accord with modern astronomical measurements of the Zeeman effect of solar absorption lines which give a magnetic field essentially zero[4].)

It may be perfectly true that the sun has no appreciable dipole moment, and we do not wish to imply that this is not the case. However, without questioning the validity of the conventional arguments employed, we merely wish to show here that their correct application does not lead to the same conclusion, since even with a magnetic moment of magnitude sufficient to explain the latitude cut-off, the diurnal variation to be expected would be so small as to be practically undetectable. This assertion is based essentially on a detailed recalculation of the diurnal variation using the basic results of Kane, Shanley and Wheeler[5], and the explicitly and very clearly presented methods of Dwight[3]. In particular, we make use of a dipole moment of $0{\cdot}65 \times 10^{34}$ (instead of 1×10^{34}) gauss cm.$^{-3}$ and a primary rigidity spectrum corresponding to the empirically observed integral spectrum[1,6] which has an exponent of $-1{\cdot}1$ in the region sensitive to latitude (instead of $-1{\cdot}75$). Both changes tend to reduce the diurnal variation.

(*a*) In order to deal with an actual situation, we will attempt to analyse the experiments of Bergstralh and Schroeder[3] performed at lat. 56°, near the optimum latitude for observing the diurnal variation[3]. To obtain the maximum diurnal spread, one first computes the exact shape of the diurnal variation for a particular solar magnetic moment and rigidity spectrum[3] (cf. columns (3) and (4) of the table).

Diurnal Variation of Primary Cosmic Radiation at Lat. 56°
Calculated for various values of the solar magnetic moment and the exponent of the integral primary rigidity spectrum

Solar magnetic moment (gauss-cm.^{3})	Fill-up, φ, of trapped orbits (per cent)	Max. diurnal spread for exponents of $-1{\cdot}75$ and $-1{\cdot}1$ of primary rigidity spectrum: with orbits empty		with orbits filled	
		$-1{\cdot}75$	$-1{\cdot}1$	$-1{\cdot}75$	$-1{\cdot}1$
		per cent	per cent	per cent	per cent
$1{\cdot}0 \times 10^{34}$	92*	92·5†	75	7·4	6
$0{\cdot}65 \times 10^{34}$	95‡	60‡	55	3	2·5
$0{\cdot}42 \times 10^{34}$	96·5*	45†	35	1·6	1·2
(1)	(2)	(3)	(4)	(5)	(6)

* Deduced from Fig. 4 of ref. 5 ;
† Scaled from Fig. 3 of ref. 2 ;
‡ Interpolated values.

(*b*) It is next necessary to take account of the filling-up of forbidden orbits (that is, 'trapped' orbits which do not come from infinity and are therefore outside of the allowed cone). Alfvén[7] first pointed out that these orbits might be filled up to an appreciable extent with particles which, although forbidden to enter them, have been scattered by the earth's magnetic field into trapped orbits. More refined calculations have been performed by Wheeler *et al.*[5] for two solar moments (1×10^{34} and $0{\cdot}42 \times 10^{34}$ gauss-cm.^{3}). By considering the scattering effect of the earth's field which, so to speak, 'punches a hole' into the magnetic screen produced by the sun, and taking into account removal of these

particles by collisions with the earth and other planets, they have computed the percentage, $\varphi_{diff.}$, to which the forbidden orbits are filled up, as a function of the magnetic rigidity of the primaries. From their results we have deduced the values of φ in column (2) of our table by some numerical integrations and a reasonable interpolation. It is to be noted that the 'average' φ of 90 per cent used by Dwight[2] gives values for the diurnal variation which are too high by a factor of 2–3 for the lower values of solar magnetic field. (This sensitive dependence on φ arises because the values of actual diurnal variation in columns (5) and (6) are obtained by multiplying (3) and (4) by $(100 - \varphi)/100$.)

(*c*) The final value for the calculated maximum variation, 2·5 per cent, must be reduced somewhat when comparing it with experimental results; a 'smearing-out' of the peaks of the variation occurs, as it is necessary to average over time intervals sufficiently long to give a statistically significant number of counts.

(*d*) We must therefore compare a calculated variation of 2 per cent (rather than 9 per cent) with the experimental value of $0 \pm \sim 1$ per cent[3]. We do not believe that they differ significantly.

(*e*) In combination with the conclusions of the preceding communication, it would appear then that none of the present *experimental* results in cosmic rays can be used reliably as evidence against the existence of a solar dipole moment up to a limit of about $0{\cdot}65 \times 10^{34}$ gauss-cm.[3].

The present investigation is perhaps of more than academic interest since, on one hand, it has been suggested that the sun's magnetic field undergoes a periodic variation[8]; on the other hand, the validity of drawing any conclusions about a general magnetic field of the sun from measurements of the Zeeman effect in the turbulent absorbing regions of the solar atmosphere has been questioned[9]. It is of importance, therefore, to examine critically all cosmic-ray evidence which purports either to deny or affirm a solar magnetic field.

Additional Considerations. The calculated diurnal variation can be reduced even further when it is noted[5] that the population of the trapped orbits is increased if planets, in particular Mars and Venus, possess a magnetic moment, as appears very reasonable. In addition, further holes can be punched in the magnetic screen by solar corpuscular streams carrying magnetic fields outward through the planetary system. Their rate of occurrence is appreciable compared to the time constant of the trapped orbit particles, which is about 5,000 years[5]. By means of these additional influences, particles may be admitted into the vicinity of the earth which have energies lower than the helio-magnetic cut-off. Such particles, which could enter the earth only at high latitudes, have not been observed in appreciable numbers. This objection may perhaps be met by noting that (i) they might be few in number originally; and (ii) if admitted they will be removed very quickly through ionization loss in interplanetary matter, an effect which can be neglected at higher energies[5]. (For example, a proton having a rigidity of $0{\cdot}5 \times 10^9$ V. possesses kinetic energy of $0{\cdot}12 \times 10^9$ eV., corresponding to a range of 10 gm./cm.[2]. The average[5] path-length is 25 gm./cm.[2] and may well be longer at low energies.)

These considerations again point to the importance of conducting cosmic ray measurements at high altitudes and high latitudes on a continuous basis, preferably correlated with similar measurements at intermediate latitudes.

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Feb. 9.

[1] Van Allen, J. A., and Singer, S. F., *Phys. Rev.*, **78**, 819 (1950).
[2] Dwight, K., *Phys. Rev.*, **78**, 40 (1950), and references therein.
[3] Bergstralh, T. A., and Schroeder, C. A., *Phys. Rev.*, **81**, 244 (1951); the diurnal variation described by Elliot, H., and Dolbear, D. W. N. (*J. Atm. and Terr. Phys.*, **1**, 205; 1951), refers to cosmic rays of very much higher energies and is presumably due to another mechanism.
[4] von Klüber, H., *Mon. Not. Roy. Ast. Soc.*, **3**, 2 (1951), and references therein; Kiepenheuer, K. A. (in the press); and Thiessen, G., *Nature*, **169**, 147 (1952).
[5] Kane, Shanley and Wheeler, *Rev. Mod. Phys.*, **21**, 51 (1949); this paper contains a particularly lucid account of the whole problem of trapped orbits.
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[9] Alfvén, H., *Nature*, **168**, 1036 (1951).

AN UNUSUAL TRANSFORMATION OF ISOMERIC FORMS OF TETRAACETYL D-RIBOFURANOSE

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1 : 2 : 3 : 5-Tetraacetyl D-ribofuranose was first prepared by Howard, Lythgoe and Todd[1] by hydrogenolysis of 1 : 2 : 3-triacetyl 5-trityl D-ribose, followed by acetylation of the resulting 1 : 2 : 3-triacetyl D-ribose. The compound had melting point 58°, $[\alpha]_D^{25°} + 20°$ ($c = 0{\cdot}645$ per cent in chloroform). Later, Bredereck and Hoepfner[2] obtained a tetraacetyl D-ribose of melting point 56°, $[\alpha]_D^{20°} - 3{\cdot}6°$ (in methanol) by treatment of 1 : 2 : 3-triacetyl 5-trityl D-ribose with acetyl bromide in acetic anhydride solution. There is no reason for doubting the identity of this compound with that obtained by Howard, Lythgoe and Todd. In 1950, Zinner[3] reported that direct acetylation of ribose yielded a mixture of 1 : 2 : 3 : 4-tetraacetyl D-ribopyranose and a new tetraacetyl D-ribofuranose, melting point 82°, $[\alpha]_D^{24°} - 12{\cdot}6°$ ($c = 12{\cdot}83$ per cent in chloroform), $[\alpha]_D^{24°} - 15{\cdot}4°$ ($c = 7{\cdot}227$ per cent in methanol), which was named 'β-tetraacetyl D-ribofuranose'. The present communication is concerned with its relationship to the previously known isomer.

In 1949, one of us (J. Davoll) prepared several batches of tetraacetyl D-ribofuranose by Bredereck and Hoepfner's method. While the first three of these preparations had melting point 56–58°, the fourth run yielded a compound of melting point 85°, $[\alpha]_D^{23°} - 12°$ ($c = 2$ per cent in chloroform), $[\alpha]_D^{22°} - 13{\cdot}5°$ ($c = 5$ per cent in methanol). This compound had the composition of a tetraacetyl ribose (found: C, 49·25; H, 5·75; acetyl, 53·9; calc. for $C_{13}H_{18}O_9$: C, 49·05; H, 5·7; acetyl, 53·9 per cent) and proved to be identical with a specimen of 'β-tetraacetyl D-ribofuranose' prepared by Zinner's

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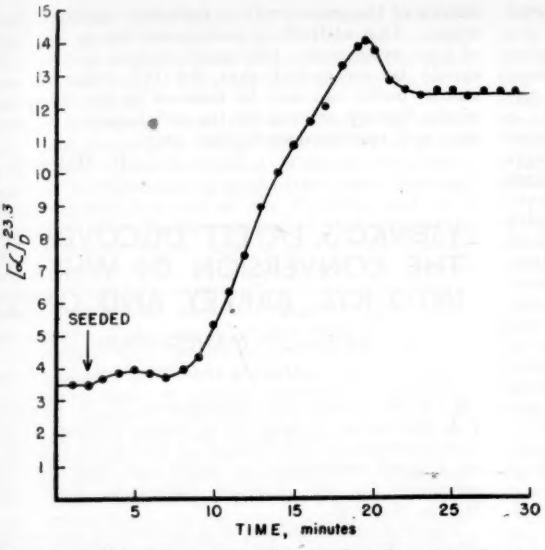


Changes in specific rotation accompanying transformation of the form of melting point 56° to that with melting point 85° in methanolic solution

method[3]. Its furanose structure was proved by its conversion, through the acetochloro compound, to adenosine[4], in yields similar to those obtained from the tetraacetyl ribofuranose of melting point 56–58°.

It was now found that the melting points of samples of the earlier preparations had risen to 85°, and it proved impossible to prepare the form of lower melting point. When a sample of melting point 56°, obtained from Prof. Todd's laboratory, was exposed to the air in a laboratory inoculated with the form of higher melting point, the crystals rapidly became opaque and their melting point was then found to be 85°. (We wish to thank Dr. S. Trippett for providing this sample. Prof. Todd, whom we wish to thank for his criticisms of the manuscript, has informed us that the transformation to the isomer of higher melting point has now been observed at Cambridge.) Dr. Visser has studied the catalytic effect in the solid state under more controlled conditions. Inoculation of a dried sample (1 gm.) of melting point 57° with 1 mgm. of that with melting point 85° (obtained from the Sloan-Kettering Institute) raised the melting point to 75–77° within two hours, and to 77–79° overnight; this was further raised to 84–85° by recrystallization. An odour of acetic acid was noted during the transformation.

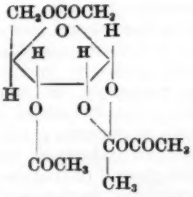
Dr. Visser has also shown that the catalytic effect operates in methanolic solution. Immediately after opening the sample of the isomer of melting point 85°, a previously prepared methanolic solution ($c = 2{\cdot}94$ per cent) of the isomer of lower melting point in a polarimeter tube was inoculated with a minute amount of the higher melting form. The subsequent changes in optical rotation of the solution, confirmed in a duplicate experiment, are shown in the accompanying graph.

A satisfactory explanation of these observations must account for: (*a*) a structural change in the molecule to account for the alteration in optical rotation; (*b*) the catalytic effect, in solution and in the solid state, of the form of higher melting point; and (*c*) the complexity of the change in specific rotation shown in the graph, which indicates the presence of at least three molecular species.

If the isomer of melting point 56° is denoted by *A*, and that of melting point 85° by *B*, the catalytic effect might be explained by a reaction (probably involving acetyl migration) between *A* and *B* to give a compound which might then become rearranged and dissociated to give two molecules of *B*:

$$A + B \rightarrow A \,.\, B \rightarrow B + B.$$

We have been unable to determine the nature of the difference between the two isomers. The closeness in specific rotation of the two forms, and the facility of the conversion of the 56° into the 85° isomer, are against simple α, β isomerism. It is also possible that one form has the orthoacetate anhydride structure shown (which, like the acetylated carbohydrate methyl orthoesters[5], might be expected to give rise to a normal acetyl glycosyl halide), though this structure is difficult to reconcile with the stability of both forms to water and ethanol. Only one compound of the same type appears to have been prepared, namely, an amorphous octa-acetyl maltose[6], the properties of which have not been reported.



The difficulty of again obtaining the lower melting isomer in either of these laboratories has prevented further study of this remarkable transformation.

This investigation was supported by grants from the National Cancer Institute, of the National Institutes of Health, Public Health Service, and from the Atomic Energy Commission, Contract *AT*(30–1)–910, to the Sloan-Kettering Institute, and from the United States Public Health Service to the University of Southern California. [Jan. 9.

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[4] Davoll, J., Lythgoe, B., and Todd, A. R., *J. Chem. Soc.*, 967 (1948).
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MANAGEMENT IN SCOTLAND

IN a paper submitted to the Scottish Management Conference which was held at Gleneagles during April 25–27, Mr. B. A. C. Hills, controller of S. Smith and Sons, Ltd., suggested that what is most urgently needed in industry to-day is the realization that behind high-sounding labels lie ordinary actions which not only can be applied to businesses but also should be. Line production, for example, is too often only associated with mass production of cars and refrigerators, whereas it could, in fact, be used in the majority of factories.

The principles of economic manufacture demand the maximum output of finished goods from the minimum total resources in material, labour, equipment, time and money, or, more simply, the reduction of costs. The main principles should be, first, the need for the constant inter-relation of all costs; a reduction in total costs may involve a deliberate increase in some items, such as the use of larger components, for example, to reach a higher degree of standardization. Secondly, the standardization of materials, sizes and shapes of components; excessive variety is one of the most common causes of high costs. Thirdly, a higher degree of mechanization. There should be a national policy to transfer labour to the production of capital goods. Fourthly, the establishment of methods-time measurement; this is a new and potent weapon in the achievement of economic manufacture which will be of particular value to the medium-sized firm not necessarily engaged in large-scale production. Fifthly, the indirect operation should be eliminated or reduced to the minimum; the siting of machines in correct sequence, instead of departmentally, can also help to reduce the indirect operation. Sixthly, a sales and design policy should be employed to produce the degree of variation in quantitative demand and of variety of products needed to keep the flow of work as regular as possible. Lastly, Mr. Hills suggested that use should be made of control data to see that costs are kept within bounds.

In his paper on the human factor in management, Sir Richard Lloyd Roberts appealed to management to "identify itself with the inevitable and welcome the employees genuinely as associates and collaborators in the joint industrial enterprise". This change in outlook is necessary because, for the first time, the problem of industrial management is now set against a background of free men in a free society.

Surveying existing man-power situations, Sir Richard suggested that personal fitness should be the only test for employment and not some arbitrary age; existing apprentice arrangements should be reviewed and better training facilities should be provided at all levels, including the young manager.

For practical application, the new concept of the status of the employee requires, first, the careful selection and placing of the individual and the provision of an induction course on entry into the firm. Secondly, his interest in the enterprise should be secured by explaining the problems involved in production, even to the extent of making him aware of the firm's plans and policies. Thirdly, working to create this new 'climate' involves management in a serious educative campaign to combat the misunderstandings that exist about the structure of industry, the role of the investor, the reasons for profit, the responsibilities of directors and management. Foremen, no less than management, must change their traditional attitudes and methods of control. Much-needed attention is now being given to the selection and training of foremen; but there is too much hesitancy about giving them adequate staff status and remuneration in relation to the men under them.

Sir Richard forecasts that piecework will ultimately disappear since its appeal is to the financial cupidity of the individual and, in the role of collaborator, this spur will not be necessary to ensure a fair day's work. The trade unions have a share in the hindrance of the full development of the human factor. Their conventional belief is that the natural alliance of any group of work-people in a given firm is with their fellows of the same craft or industry employed elsewhere. This attitude is understandable in the light of past experience; but under modern conditions it should be recognized that the full value of any human factor can only be fostered in the individual works, factory or mine by the collaboration between man and management in that unit.

T. H. Hawkins

LYSENKO'S LATEST DISCOVERY—THE CONVERSION OF WHEAT INTO RYE, BARLEY AND OATS

By Prof. P. MAHESHWARI
University of Delhi

A FEW months ago Academician T. D. Lysenko produced an interesting paper entitled "New Developments in the Science of Biological Species", an English translation of which has been recently published by the Foreign Languages Publishing House, Moscow[1].

The first half of the paper is devoted to a consideration of the concept of genus and species. In the latter half Lysenko first refers to V. K. Karapetian's[2] observation of 1948 that if 28-chromosome durum wheat (*Triticum durum*) is sown late in the autumn some of the plants are converted in two or three generations into 42-chromosome soft wheat (*T. vulgare*). This prompted Russian workers "to search for grains of soft, 42-chromosome wheat in the spikes of experimentally grown durum wheat. As a result, individual grains of soft wheat were quite easily observed in the spikes of durum wheat, i.e., *grains of one botanical species were found in the spikes of another species*" (italics mine).

That the abnormally arising grains really belonged to *T. vulgare* was confirmed by sowing the seeds which "produced, *as a rule* (italics mine), soft wheat plants". It is not mentioned as to what they produced in the remaining cases; but it may be presumed that they either did not germinate or produced durum plants.

Encouraged by this discovery, Russian botanists instituted in 1949 a vigorous search for rye grains in wheat spikes in the fields of the foothill districts sown with winter-wheat. Their efforts were amply rewarded. "V. K. Karapetian, M. M. Yakubtsiner, V. N. Gromachevsky and a number of other research workers as well as a number of agronomists and students found single grains of rye in durum- and soft-wheat spikes, i.e., in the spikes of two wheat species which grew in the fields of various foothill districts. Over 200 such grains of rye were found in 1949. . . . From these grains of rye, which had developed in spikes of durum and soft wheat, a diversity of plants was grown. These plants, *with few exceptions* (italics mine), were nevertheless typical rye. Only in a very few cases were wheat plants obtained from ryelike grains." No mention is made of the range of variability in the offspring of the rye-like grains, nor are we told the type of wheat—$2n$, $4n$, or $6n$—which arose from them in exceptional cases.

"In all the above cases where grains of one species of plant were found in spikes of another species neither the plants themselves nor their threshed spikes showed any signs whatever of being inter-

mediate forms. They seemed to be typical, ordinary spikes of durum or soft wheat. But the internal state of these wheat plants was no longer the usual one, was no longer qualitatively homogeneous in respect to species."

Other interesting facts follow. Plants of *Avena sativa* were observed to bring forth individual grains of *A. fatua*. Branched wheat (*Triticum turgidum*), grown on the experimental plots of the Lenin Academy of Agricultural Sciences of the U.S.S.R. and in a number of other localities, showed "admixtures of soft and durum wheat, oats, 2- and 4-rowed barley and also spring rye". It is stated that the original source of these admixtures was the branched wheat (*Triticum turgidum*) itself, and that this was not a consequence of the use of impure seed.

"In 1950 it was discovered in several cases that barley plants which were growing as an admixture in branched wheat crops had developed from grains which in external appearance could not be distinguished from branched wheat grains."

It is emphasized that these new facts were obtained "*in a systematic way* or as the result of *a systematic search*". The supposition that the seeds may be of hybrid origin is rejected, and it is stated that similar results can be obtained "by cultivating plants specially sown under experimental conditions for this purpose".

The paper contains a good deal more, mostly in the nature of the usual diatribe against Malthus and in praise of Timiryazev and Michurin. Stalin's name is also mentioned; but leaving the political issue aside and taking only the scientific part into consideration, the present position is considerably different from that a few years ago when stray rye plants were mentioned as appearing in wheat fields. Geneticists in Britain and the United States explained such an occurrence as caused by sowing mixed seed. Now our Russian colleagues claim that there is no question of mixture, for rye grains are said to have been found *within* wheat spikes and "could not possibly have been introduced into these spikes from without by either birds or man in any other way".

The possibility of hybridization or the influence of foreign pollen is rejected in the following words: "The supposition that these seeds might be of hybrid origin also goes by the board. It is a known fact that wheat can be crossed with rye, though seldom. However, in these cases the product obtained is an obvious rye–wheat hybrid which can readily be distinguished from wheat and rye by its external appearance. Besides, rye-wheat hybrids, as a rule, are self-sterile; they yield no seeds unless they are pollinated with the pollen of one of their parents, preferably the wheat. In the case at hand the grains of rye from the wheat spikes produced ordinary rye plants with normal fertility. The said plants manifested no hybrid properties whatever".

Academician Lysenko thinks that so far as plants are concerned the problem of speciation has therefore been solved, and a change in environment is the key to its solution. With regard to animals also he is quite hopeful as the following quotation will show: "We do not yet have the data essential to demonstrate how species are formed in the animal world. But we may rest assured that before long the development of the theory of Michurinist biology will make it possible to accumulate data also for zoological objects analogous to the data taken from the world of plants".

This much about Lysenko's science. As the result of the work of Kihara, Sears and others, enough is, however, known of the cytology of wheat, rye, barley and oats to make one extremely sceptical of his claims about the conversion of one into another. Some of these doubts are mentioned below.

(1) Lysenko says that grains of soft wheat found in spikes of durum wheat *as a rule* produced soft wheat plants. What did they produce in other cases?

(2) How did wheat plants arise from a few of the rye-like grains? Does this mean that rye can in turn become converted into wheat? Were these wheats diploid, tetraploid or hexaploid?

(3) Since rye has 14 chromosomes, by what method could a vulgare wheat ($2n = 42$) give rise to rye? Not only is the number of chromosomes different in the two cases but also the morphology of the chromosomes. For example, pines have $n = 12$ chromosomes and so have the lilies; but it is not possible to convert one into the other.

I think that there is no possibility whatever of changing tetraploid wheat into a hexaploid type as the result of environmental influences only, although the Russians claim to have accomplished it many years ago. Conversion of wheat into rye, barley and oats is fantastic and even more unbelievable. To understand this, we must have a mechanism for the deletion of the three genomes, *A*, *B* and *D*, present in *T. vulgare*, or *A* and *B* present in the emmer wheats and the appearance of a new rye, barley or oat genome. This, most people will agree, is not possible by environmental changes.

However, this is not the first time that such reports have appeared. Many years ago Virgil and Pliny wrote how farmers planted wheat and barley only to discover to their annoyance that some of the seed produced wild oats. Thomas Johnson[2] in 1633 reported the occurrence of a grain of oat in an ear of wheat, and Ole Worm[3] in 1655 claimed to have seen a rye grain in an ear of barley.

Most botanists outside the U.S.S.R. are inclined to dismiss all such reports as errors of observation or as faked. Judging from the exaggerated nature of Russian reports and the lack of proper data for an evaluation of their claims such a surmise is not unnatural. However, if rye grains do occasionally occur in wheat spikes, the only possible explanation is that the stigmas of some of the wheat flowers become pollinated by rye pollen. In most cases, perhaps, such pollen tubes would fail to reach the ovules. If they did it is possible that either the eggs may be stimulated to develop parthenogenetically; or there is a fusion of the female nucleus belonging to the wheat parent with the male nucleus contributed by the rye parent, resulting in hybrid progeny; or the male gamete develops 'androgenetically' inside the embryo sac, seed coat and pericarp of wheat. In the third case the offspring would be a haploid rye, but if chromosome doubling took place at some stage in embryogeny the mature grain would produce a normal diploid rye plant. The so-called 'conversion' of wheat into barley or oats could also be understood as occurring in the same manner.

Such 'androgenesis' is already known to occur in *Nicotiana* and *Crepis* (see Maheshwari[4] for references; also Darlington and Mather[5]), and the work on *Crepis* was done by a Russian botanist, Helen Gerassimova[6]. Lysenko is either not acquainted with the literature on cytology, embryology and genetics or is unable to take this into account because of a blind faith in environment.

It is hoped that other botanists who see this note will express their opinions on this wheat–rye conversion and that meanwhile Russian botanists will themselves present a cytological analysis of the converted wheat or rye plants.

[1] Lysenko, T. D., *Agrobiologia*, **6** (1950); English translation, "New Developments in the Science of Biological Species", Foreign Languages Publishing House, Moscow (1951).
[2] Karapetian, V. K., *Agrobiologia*, **4** (1948).
[3] Dunn, L. C., "Genetics in the Twentieth Century" (1951).
[4] Maheshwari, P., "An Introduction to the Embryology of Angiosperms" (1950).
[5] Darlington, C. D., and Mather, K., "The Elements of Genetics", p. 168 (1949).
[6] Gerassimova, H., *Planta*, **25** (1936).

MICRO-MAGNETIC VARIATIONS DURING THE SOLAR ECLIPSE OF FEBRUARY 25, 1952

By Prof. N. F. ASTBURY
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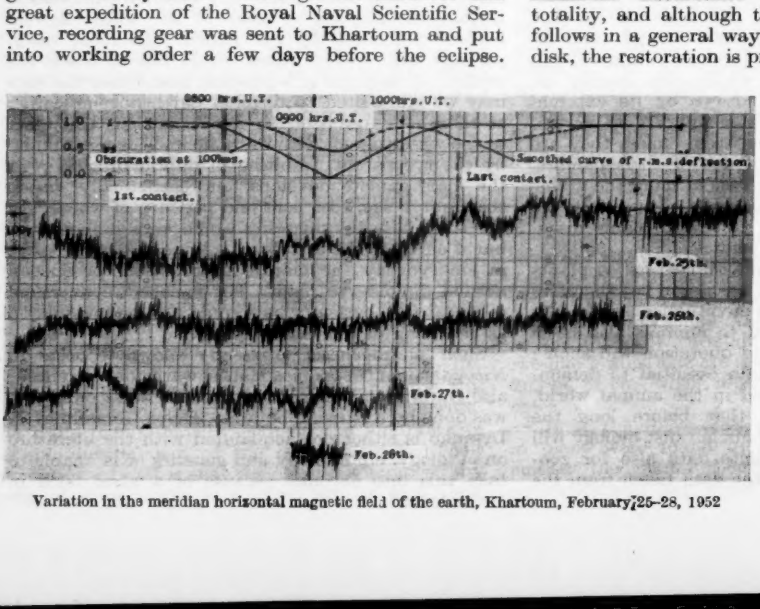
THE occurrence this year of a solar eclipse the totality zone of which crossed the magnetic equator provided a special opportunity for the observation of variations of small amplitude in the earth's magnetic field. During the Second World War, I was able to observe (but not to publish for security reasons) variations in the earth's field in the frequency-range 0·005–200 c./s. in northern auroral latitudes. In the stress of war-time conditions it was not possible to investigate causes of or possible cyclic changes in these variations, so that the opportunity of examining corresponding phenomena near the magnetic equator, especially during a total eclipse, was particularly interesting.

The observations planned for the total eclipse of February 25 were necessarily very simple, because of the short time available for preparations. The plan was to observe changes in the meridian horizontal component of the earth's field, and the site chosen was in the grounds of University College, Khartoum, about 5 km. north-east of the centre line of the ground totality zone. Through the kindness and great expedition of the Royal Naval Scientific Service, recording gear was sent to Khartoum and put into working order a few days before the eclipse. The detector used was a coil of about two metres diameter, carrying 540 turns, set up in a vertical plane with its axis in the magnetic meridian. This was connected to an integrating D.C. amplifier and to a low-frequency thermionic amplifier with a frequency range of 5–200 c./s. The time-constant of the D.C. amplifier and associated circuits was about 40 sec., so that its response to a sinusoidally varying flux was a maximum for changes of about this period, falling to about 90 per cent for periods of 5 sec. and to about 60 per cent for periods of 200 sec. For signals near the optimum period a displacement of 1 mm. on the recorder trace corresponded to a field change of 10 gamma. Such preliminary experiments as were possible showed at once that while it would be satisfactory to work with the D.C. gear in this condition, heavy and variable industrial interference made the operation of the low-frequency amplifier unreliable. For the eclipse work this had therefore to be abandoned, but it will be set up outside the town later.

For the eclipse observations, the recorder was run with a paper-speed of 1·25 in. per min. to secure high resolution. Observations were started half an hour before sunrise (0330 hr. U.T., 0530 hr. L.T.) and were continued until half an hour after sunset. The record showed a marked change in character during the eclipse, variations of amplitude about 100 gamma and period 20–30 sec. giving way to disturbances of half the amplitude or less and of much longer period. The concise presentation of such a record is a matter of some difficulty, and two methods have been attempted. In one, the mean square deflexion has been computed for every four-minute interval of the record, and the resulting curve smoothed. In the other, a mechanical copy has been made of the whole record in which the paper-speed has been reduced to about one inch per minute, the deflexion being at the same time amplified about one and a half times. The accompanying chart is a copy of such a reduced record, together with the smoothed curve of root-mean-square deflexion and the obscuration curve for the 100-km. level. On the same chart are reproduced copies of control records taken on succeeding days at relevant times.

On the day of the eclipse, there is a region of minimum disturbance about ten minutes after totality, and although the descent to the minimum follows in a general way the occultation of the sun's disk, the restoration is prolonged; and it is not until four or five hours after the last contact that the disturbances have built up to their pre-eclipse level.



Variation in the meridian horizontal magnetic field of the earth, Khartoum, February 25–28, 1952

Concurrently with these observations, ionospheric recordings were made on the same site by Mr. C. M. Minnis and Mr. Clarke, of the National Physical Laboratory, using an automatic recorder of N.P.L. design. While the full analysis of both magnetic and ionospheric records has yet to be completed, there can be little doubt that changes in the variations of the horizontal magnetic field at the earth's surface were

associated with changes in the ionosphere. It is suggested that the magnetic variations are due largely to plasma oscillations in the lower levels of the ionosphere.

Subsequent 24-hr. recordings taken with a paper-speed of 1 in. per hr. have shown the existence of a marked diurnal effect, together with a curious major disturbance about an hour before sunset. It is planned to extend the work to include the vertical component of the field and to make continuous ionospheric recordings over the more significant times, and a full report will be published elsewhere. [April 27.

RESEARCH COUNCIL OF ISRAEL

ANNUAL REPORT FOR 1950–51

THE second annual report of the Research Council of Israel, covering the year ended March 31, 1951, has recently been published*. In place of the original five advisory committees, committees have now been established for fundamental research (including the utilization of the natural resources of Israel), chemical industry, textile industry, agriculture, nutrition, food industry, and building (including roads). The membership of these committees is given, with lists of publications and research papers issued during the year.

The work of the Geological Survey has been facilitated by the establishment of a palæontological laboratory. The search for additional sources of water has continued, deposits of peat have been discovered and the search for petroleum reserves continued. The Citrus Concentrates Producers Association completed successful pilot-plant trials on a process for the preparation of dry pectin of high jelly units from orange peel without the use of organic solvents, and has used ion-exchange resins to obtain a completely demineralized sugar syrup from limed citrus-peel juice. Research on pectolytic enzymes is a major activity in this laboratory, while the Ceramics Research Association has overcome difficulties experienced in slip casting due to the poor quality of the plaster by changing the conditions of fixing. The Textile Research Association has continued work on the shrink-proofing of wool with acid bromates. Medical research has included studies of the mechanical fragility of erythrocytes in the presence of sulpha-drugs and of the intestinal flora of the newly born. Biological research has covered ticks and tick-borne diseases, vole research and the mode of action of germination inhibitors. The hydrochemistry of the Sea of Galilee was studied to determine the origin of the salts in the Dead Sea, and satisfactory yields of naphthenic acids have been obtained by oxidation of kerosene containing 18 per cent of aromatic acids after removal of the latter with sulphuric acid. A survey of the source of raw materials for the manufacture of cellulose has been undertaken, and a study made of micro-organisms responsible for the retting of flax.

Building research has been done on a number of topics which include: a study of the influence of all types of roof structures and of the effect of the design, finish and material of wall structures on the internal climate; the efficiency of housing schemes for immigrants; solar heating of domestic water supplies; and the ageing of bitumen. Dew and water condensation in upper layers of soil and evaporation from open surfaces have also been investigated, solar radiation in the visible and infra-red regions was being measured, and field trials made of a number of fibre-yielding plants. A study of the population dynamics of the Mediterranean fruit fly, *Ceratitis capitata*, was initiated and also of the biological factors affecting the yield of legumes, while investigations of weeds and a study of the nutritional deficiencies of fruit trees were continued.

* Research Council of Israel. Second Annual Report for the Year ending 31 March, 1951. Pp. 32. (Jerusalem: Research Council of Israel, 1952.)

AMERICAN PHILOSOPHICAL SOCIETY

REPORT FOR 1951

THE year book for 1951 of the American Philosophical Society covers the year ended December 31, 1951*, and, besides a brief history of the Society by E. G. Conklin, biographical memoirs, lists of members and the auditor's report, includes the customary reports of the standing committees on finance, the library, meetings, publications and research. The report on research, which occupies most of the year book, details the ninety-six grants, totalling 85,305 dollars, which were awarded from the Penrose Fund during the year and gives an analysis of the distribution of grants from this Fund by subjects during 1949–51. Also detailed are five grants, totalling 9,950 dollars, from the E. R. Johnson Fund, two, totalling 4,750 dollars, from the J. Daland Fund for Research in Clinical Medicine, two from the Miclaux Fund, and twenty-eight, totalling 30,245 dollars, from the Reserve Fund for Post-war Expenditures, all of which were for research.

Among the more detailed of the reports from recipients of grants which are included (arranged alphabetically under subjects) in the report, mention may be made of that by H. Friedmann on the life-histories of the honey-guides (Indicatoridæ) and the parasitic weaver-birds (Ploceidæ) of Africa; S. M. Rose's study of induction of regeneration in limbs of lizards; C. A. G. Wiersma's investigation of the patterns of innervation of the legs in the higher crustacea, with special emphasis on the inhibitory innervation; H. E. Evans's taxonomic and biological study of the spider wasps of Mexico belonging to the sub-family Pompilinæ (Hymenoptera, Pompilidæ); W. Hovanitz's amphi-Atlantic study of *Colias hecta*, *Colias nastes* and *Colias palæno* and J. A. G. Rehn's detailed field study of the Orthoptera of the United States.

G. L. Kreezer reports on the development of methods for the determination of the components of biological systems on the basis of the mathematical analysis of transient response curves; D. C. Smith on studies in Bermuda on the thyroid glands of the parrot fish; C. L. Markert on the biochemical basis of cell differentiation; H. N. Andrews on the anatomy of *Botryopteris*; W. R. Taylor on his survey of the marine algæ of Bermuda; L. M. Langdon on a comparative survey of inflorescence characteristics in the Castaneæ; and H. P. Hansen on the study of post-glacial forest migrations and climate in Western Canada and Alaska by means of pollen analysis of

* American Philosophical Society. Year Book 1951; January 1, 1951–December 31, 1951. Pp. 452. (Philadelphia, Pa.: American Philosophical Society, 1952.)

peat sections. Reports are also included of W. H. Camp's study of the relative virulence of beech bark disease on the several types of forest beech in eastern Canada and Maine; of B. Howe's investigation of caves, shelters and other sites where it is expected that Neolithic, Mesolithic and Palæolithic remains are to be found in stratigraphic relation; of E. Murray's case study of colour-vision deficiency; and R. B. Singer's clinical and physiological investigation of disturbances of the acid–base balance of the blood, with particular reference to the effects of intravenous alkalinizing or acidifying solutions.

METROLOGY LABORATORY OF THE COLLEGE OF TECHNOLOGY, BIRMINGHAM

IN the College of Technology, Birmingham, the Production Engineering Section of the Department of Mechanical Engineering for the past five years has been developing the teaching of production techniques, particularly in the fields of machine tools, jigs and tool design, and fine measurement. In the last-named case, the new Metrology Laboratory of the College, which has been equipped at a cost of nearly £5,000, is now complete.

The functions of this Laboratory are threefold. First, it provides students with an opportunity for undertaking experimental work, and determining fine measurements using modern general and specialized equipment, the laboratory work being closely related to the lecture course. Secondly, the Laboratory is intended to provide local industry with an approved centre in which specified gauges may be measured. This project should be of particular interest to small engineering firms with only limited measuring equipment. In order to achieve this aim, the layout of the Laboratory has been supervised by the Metrology Division of the National Physical Laboratory, which has certified the equipment provided as satisfactory for an approved gauge testing centre. Further, a member of the staff who has maintained contact with the National Physical Laboratory during the development stage has qualified to act as the authorized supervisor. The gauge testing scheme is an arrangement whereby an educational establishment possessing specified measuring equipment may undertake the inspection of certain classes of gauges on behalf of the National Physical Laboratory. Inaugurated by the Ministry of Education, the scheme has the support of the Ministry of Supply, and as a result it covers the same classes of work for the Aeronautical Inspection Department. The Metrology Laboratory is authorized to undertake the inspection of parallel plain plug and parallel ring gauges; taper plain ring gauges; parallel plain gap gauges; taper plain gap gauges, and simple plain length, height, depth and thickness gauges; parallel screw plug gauges up to 4 in. diameter, of Whitworth, metric and B.A. forms of thread; profile gauges; and simple angle gauges.

The third function of the Laboratory is that its equipment, which is in excess of the requirements of the National Physical Laboratory scheme, has been designed to promote additional facilities for research —a relatively new venture, upon which staff members are now engaged. These investigations are concerned with the study of the characteristics of fine metallic surface-finishes with reference to mechanical methods of production, which has led to further studies of the influence of surface finish on friction and wear.

The Metrology Laboratory is electrically heated and thermostatically controlled at 68° F. (20° C.). Fluorescent lighting is installed. The majority of the equipment, which is almost exclusively of British design and manufacture, has generally been purchased; but certain firms have presented apparatus to the College. Apart from the essential standard gauges and measuring tools, the equipment includes measuring machines for the determination of errors in screw threads, including optical projection apparatus; a 7–36 in. end-measuring machine with accessories; and a taper diameter-measuring machine, all of which are based on National Physical Laboratory designs. Comparator-type measuring equipment representing mechanical, electrical, pneumatic and optical forms of operation are available. The issue of "Acceptance Test Charts for Machine Tools", prepared by the Institution of Production Engineers, and published in collaboration with the Institution of Mechanical Engineers, has led to the provision of equipment necessary for machine-tool alignment tests. This includes optical instruments such as the 18-in. 'Microptic' auto-collimator, reading directly to 0·5″ of arc, and an alignment telescope and target, reading to 0·0005 in., both manufactured by Messrs. Hilger-Watts, Ltd. A standard 'Angle-Dekkor', reading to 1′ of arc, is also available. Experimental apparatus for preliminary surface-alignment tests has been constructed in the Laboratory, but work of an advanced nature is carried out on standard machines in the various machine-tool laboratories. A tool-room microscope with accessories, by Messrs. Cooke, Troughton and Simms, Ltd., has been provided for the measurement of angles, thread forms, linear displacements, and for the comparison of enlarged projected images.

Surface-texture measurements may be carried out using the latest Taylor Hobson 'Talysurf' Model 3. This machine measures the roughness of surfaces by traversing a stylus across the surface and electrically amplifying its movements. The result of the examination may be shown in the form of a graph indicating the nature of the surface undulations. Alternatively, an average number may be recorded indicative of the degree of roughness. A model of the well-known 'Tomlinson' mechanical surface-recorder, in which a trace is made on a smoked glass, provides an alternative method of surface measurement.

As the Laboratory is for the use of senior students taking the craftsman's course, as well as for students in advanced professional courses, apparatus in the form of gauges in common use has been constructed for examination. All experimental work is based on instruction sheets giving details of the equipment to be used and the procedure to be followed. The theory underlying the particular experiment is also shown. Students prepare full records of all work done and are expected to develop logical conclusions. In the case of direct measurement, particular emphasis is laid on the errors of determination. The application of British Standard specifications is an important aspect of the lecture work. Copies of pertinent specifications, and other relevant publications, are available in the Laboratory, and students are urged to study them with reference to the apparatus being used. In conclusion, it is not suggested that the development of metrological studies in the College is now complete; on the contrary, it is hoped that future developments will allow the work to expand considerably.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Selection of the Genetic Basis for an Acquired Character

THE experimental results reported recently by Prof. C. H. Waddington[1] seem to make explicit in an important way what some zoologists, not professional geneticists, may have felt for long as something unsatisfying in many of the translations of evolutionary problems into Mendelian terms with which we are all familiar. He has reminded us once more that artificial selection, and so by presumption natural selection, acts upon animals having qualities, such as crossveinlessness, and not upon genes. He has shown that there are more genetic ways than one of being a crossveinless fruit-fly, and that, if crossveinlessness is selected for, then crossveinlessness will become established in a relation to the underlying genetic structure about which it is not clear that anything can in principle be predicted.

This most significant work seems to point once more to an element of insecurity in those approaches to the evolutionary problems of biology which by implication or statement rest upon the belief that these problems would be solved if we knew all about the distributions of genes in populations through time. Prof. Waddington has shown that again in his example the relation between the gene and the character is of just such a kind as will *not* enable us to say anything at all about genetic mutation-rates, or, indeed, genetic situations in any sense, in populations of which we know only the appearance through time. May it not also be true that this relation is of such a kind as will *not* enable us to say anything at all about the appearance through time of a population of which we know only the genetic make-up? Have we not been forced to ascribe to the genes qualities and potentialities which impair the biological relevance of any knowledge of them to which we can in principle attain? Part of the population of crossveinless flies at Edinburgh has changed the genetic basis of its crossveinlessness; but could future workers, examining them dead, in principle know this? A genetic situation at Edinburgh has become established by selection, in a relation (supposedly new) to crossveinlessness; but could future population geneticists, seeking to calculate what must have been the frequencies of all genes in Edinburgh, have said anything about the way in which this would happen, or about the new relation which was to be established? Possible future positions in a game of chess can be predicted from a given position, but only, in any practical sense, if the rules are kept. If a pawn can become a queen we must know what makes it a queen: for example, arrival at a certain place on the board. Procedural difficulties seem likely in making a prediction if what makes a pawn into a queen is its relation to other pieces *and* the necessity that white should win.

Much important recent work has given us a view of the widely differing rates of change through geological time in different groups of animals. Prof. Waddington has surely reinforced the impropriety of saying, and still more of implying, that this information is information about genetic change, whether by mutation, recombination, or of any other kind. We may not say that lampshells have low rates of genetic change; we may only say that they look alike through long periods. Whether or not the success of a lampshell now is in any intelligible sense a consequence of the same genetic situation as made a lampshell similar to look at, and apparently equally successful, in different conditions a long time ago, is simply unknown, and now looks a little more unknowable. Perhaps Prof. Waddington has made us understand that to ask such a question is not sensible, and to answer it vain.

It may perhaps be urged that Prof. Waddington's example is exceptional, and that possibly argument from, for example, the homology of mutations, may show that, in general, characters are, have been, and will remain, 'due' to genes in a way that will justify translation of thought about populations into thought about genetics, and *vice versa*. But is this now, remembering again the warning of Harland[2], that "there are as many ways of making petal spot as there are species", more than a gratuitous judgement? Does it even save the phenomena in a Ptolemaic sense? Does it really save anything? Does it not rather reduce the Mendelian concept to tinkling symbols in circumstances where they may not be the most appropriate?

PAUL G. 'ESPINASSE

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University College,
Hull. May 19.

[1] Waddington, *Nature*, **169**, 278 (1952).
[2] Harland, Proc. Seventh International Genetic Conference (1939).

Recent Echo Sounder Studies

HODGSON[1] has shown that shoals of several species of fish give rise to traces on echo-sounders, and that a species may be identified by the shape of its trace. Echo-sounder records taken more recently by research vessels of this and other laboratories have shown that traces can be caused by an increasing variety of organisms covering a wide range of sizes, and that physical discontinuities in the water column are often associated with pronounced traces. For example, in August 1951 traces were obtained over a wide area off Whitby by the R.V. *Platessa*, using a Marconi sounder. They were found to be at a depth corresponding to that of a sharp thermocline, and small whiting about 3 in. in length, large medusæ, herring and *Ammodytes* larvæ were caught with a pelagic trawl at the depth of the trace. As the thermocline persisted outside the area in which the traces were recorded, the echo could not have been caused by the thermocline itself.

At about the same time, the R.V. *Ernest Holt*, working in the neighbourhood of Hope Island in the Barents Sea, found up to five simultaneous, relatively thin, horizontal traces in the upper 40 fathoms. These echoes persisted through other dense traces, which were associated with fish and other organisms; their depths coincided with those of marked temperature gradients obtained on bathythermograph records; and they exhibited oscillations due to internal waves. The traces were obtained on a Kelvin and Hughes *M.S.*24 30-kc. sounder using a 1,500-volt output and a 3-stage amplification, and on a Kelvin and Hughes *M.S.*21*b* 10-kc. sounder with a 2,000-volt output and a similar amplification. Similar traces were also recorded off southern Spitsbergen, where, as in the Hope Island area, relatively warm Atlantic

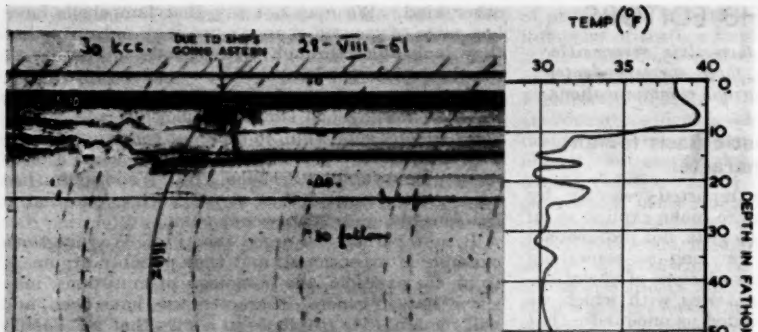

Fig. 1. Vertical temperature profile as recorded by the bathythermograph superimposed on the echo-sounder record

Fig. 2. 10-kc. Echo-sounder record from same cruise showing traces of individual cod, each of approximately 80 cm. length

water and cold Arctic water meet and give rise to a marked but complicated layering of the water. The nature of this hydrographical structure and the multiplicity of the traces suggest that the echoes could not have been caused entirely by planktonic organisms. Joseph[2] has shown, however, that sharply demarcated zones of high turbidity may exist in the sea. In the absence of more direct evidence, such factors cannot be excluded, and the traces cannot be attributed entirely to the structure of the water column. Further work is planned to determine the cause of these traces.

Hodgson and Richardson[3] have demonstrated the value of the echo-sounder as a means of studying shoal behaviour under varying stimuli. Traces obtained by the R.V. *Ernest Holt* suggest that sensitive echo-sounding equipment may also be used for studying the reactions of single fish. Single live cod of mean length 80 cm. were released from the lee rail and followed to 60 and 35 fathoms depth using full gain on the 10-kc. and 30-kc. sounders respectively. Similar depths were obtained using air-free cod, from which the air bladder and all tissue that might trap air had been removed. The sea was calm, but strong tidal streams were experienced; and it is not known whether the cessation of the traces at the depths stated above was due to the movement of the fish out of the sound cone or to the return signal strength of a single fish being below the threshold of sensitivity of the instruments. Comparisons between the depths to which cod could be recorded on each of the two frequencies cannot be made because of the different output of each machine.

Some of the live fish were seen to halt at the 'discontinuity trace' for a short time—one or two minutes—before continuing their descent. This reaction was not invariable and requires further investigation. It was observed when the temperature discontinuity was of the order of 3° C. in 10 ft.

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Trematode Life-Cycle enacted in a London Pond

It is well known that the larval trematode "*Diplostomum volvens* Nordmann, 1832" may cause impaired vision, and even blindness, in certain fishes. Rushton[1] and Baylis[2] have reported the presence of this diplostomulum in the eyes of rainbow trout in Britain. The presence of 20–40 parasites in the lens of each eye may favour completion of the life-cycle,

because the fish then falls an easier prey to water birds. The definitive hosts of this trematode, *Diplostomum spathaceum* (Rudolphi, 1819), are various species of gulls, and the usual location is the intestines[3].

The eggs of this trematode hatch in water and the forthcoming miracidia penetrate water snails, generally *Limnæa stagnalis*, giving rise to colourless sporocysts from which the fork-tailed *Cercaria C* Szidat[4] emerge and promptly leave the snail. These pelagic larvæ float at various levels in the water in a highly characteristic posture; the furcal rami are divaricated and held uppermost, and the proximal region of the tail-stem is flexed so that the elongate body is held almost parallel with one of the rami. The cercariæ come in contact with fishes by chance, and after penetration they lodge in the eyes, getting into the lenses. Gulls obtain the trematode by devouring infected fishes.

I have recently observed that the entire life-cycle of *Diplostomum spathaceum* is being carried out in and on a very small, gravelly pond in London, not more than four miles from Charing Cross. The pond, often used for sailing model ships, contains much blanket-weed, decomposing leaves and other jetsam, and it accommodates various ducks and gulls. From it I obtained many large *Limnæa pereger*, most of which were heavily infected with trematode larvæ, double and triple infections being fairly common. The presence of dead and dying snails testifies to the intensity of the infections. By isolating living snails I have obtained daily several broods of cercariæ of stylet, fork-tailed and echinostome types. The fork-tailed larvæ were readily identified as *Cercaria C* Szidat, a study of which enables me to confirm most the behavioural characteristics outlined by Szidat[5] in Germany and Wesenberg-Lund[6] in Denmark. I have also noted the marked pathogenic effect of this cercaria on fishes.

Nearly every one of thirty three-spined sticklebacks more than 2 cm. long taken from this London pond had about twenty *Phyllodistomum folium* (v. Olfers, 1817) in the ureters and twenty to forty "*Diplostomum volvens*" in the lens of each eye. The re-infection of some of these fishes with *Cercaria C* revealed within a few hours both well-developed diplostomula and tailless cercariæ in the eyes. Such mixed infections as this illustrate the fact that the type of metacercaria which we call the diplostomulum undergoes considerable development in the fish host. The metacercariæ of a trematode such as *Fasciola hepatica* which encyst on herbage in the open do not develop further until they are taken in by the definitive host. At the other extreme, as it were, the metacercariæ of *Diplostomum spathaceum*, which are nourished at the expense of lens tissue, develop a completely transformed fore-body, which comes to have all the characters of the adult's body, and a rudimentary pouch-like hind-body which reaches full size in the final host only after the gonads have come to full development.

In my experiments, which will be reported fully elsewhere, I have determined that penetrating *Cercariæ C* kill minnows, goldfish, common carp, bitterling carp, tench, stone loach, perch and small sticklebacks overnight, and tadpoles within fifteen minutes. The fact that a few hundred cercariæ (which is only a fraction of the daily emission from one snail) will kill half a dozen fishes illustrates the intense pathogenic effect. From the eye of one minnow exposed for only a few hours to *Cercaria C* I have recovered nearly two hundred metacercariæ. The crucian carp seems to have greater powers of resistance than other fishes used in these experiments, but it cannot withstand three successive infections at two-day intervals. The nature of this severe pathogenicity is being investigated. One suggestion regarding the death of fishes is cerebral hæmorrhage caused by penetrating cercariæ.

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Moonlight and the Pregnancy of Malayan Forest Rats

DURING the past four years, records have been kept of the state of pregnancy of a large number of rats and squirrels of various species collected and killed in connexion with scrub-typhus investigations. While studying the relation between rainfall and breeding season[1], it was found that the rates of pregnancy of the nocturnal forest rats showed a bi-monthly rhythm which appeared to be in phase with the moon, and which suggested that the greatest number of conceptions occurred near the time of full moon.

To investigate this further, the distribution of intra-uterine litters in the lunar month was calculated. Litters were classed as 'young' or 'old' according to whether the mean weight of the embryos was below or above the median of such weights for all litters of that species. There is some evidence[2] that, although intra-uterine mortality occurs, it affects individual embryos rather than whole litters; and if the loss of litters can be neglected, then the median (that is, the central) value for all litters will be the best estimate of the value at the mid-point of intra-uterine life. We do not know the gestation period for any of these animals, but by analogy with other members of the same family (white rat, black rat, white mouse, wood mouse, deer mouse, vole[3]) it is likely to be about twenty days, so we shall probably not be far wrong if we allow ten days for the life of a 'young' embryo and a further ten for the 'old'.

The dates on which the various litters were examined were then recalculated on a lunar calendar, as number of days from the new moon, and the results were grouped for the whole period for nearly four years. The result for one of the giant rats, *Rattus mülleri*, is shown in Table 1, grouped by five-day periods. There is, in fact, an excess of 'young' litters in the middle of the lunar month and excess of 'old' ones at the end; but the numbers involved are too small to eliminate the possibility of such differences

Table 1. Numbers of 'young' and 'old' litters of a forest giant rat, *Rattus mülleri*, by five-day periods of the lunar month (new moon = 1, full moon = *c.* 16) consolidated for the whole period April 1948–December 1951

Lunar dates	1–5	6–10	11–15	16–20	21–25	26–30
'Old'	2	1	1	0	4	4
'Young'	3	0	2	4	0	3
Total	5	1	3	4	4	7

Table 2. Same information as Table 1 consolidated for forest rats of the species *R. mülleri*, *R. sabanus*, *R. whiteheadi* and *R. rattus jalorensis*

Lunar dates	1–5	6–10	11–15	16–20	21–25	26–30
'Old'	10	10	8	8	15	21
'Young'	12	12	16	14	5	13
Total	22	22	24	22	20	34

$\chi^2 = 16{\cdot}7$. $P < 0{\cdot}01$.

being due to random variation. In Table 2, therefore, similar results for 144 specimens of the four most common species of rat from the forest, *R. mülleri*, *R. sabanus*, *R. whiteheadi and R. r. jalorensis*, are grouped. Since the classes 'old' and 'young' have been chosen to make them equal, and since sampling in the trapping register shows that the numbers examined in each period of the lunar month have been approximately equal, the number of litters expected in each box of the table is the same, namely, twelve. For the first two periods this is approximately true, for the next two there is an excess of 'young' litters, and for the last two a similar excess of 'old' litters. A χ^2-test gives a probability of less than 1 per cent that such differences are due to chance variations.

As a litter spends some ten days in the 'young' group, it is evident that there must be a burst of conceptions in the period immediately before the full moon, roughly coinciding with the sudden increase in effective moonlight which occurs at about the tenth of the lunar month.

That this phenomenon is likely to be a direct effect of the moonlight is shown by similar figures for the diurnal squirrels trapped in the same localities (Table 3). The numbers are rather smaller and have been grouped by ten-day periods; but it is clear that they do not differ significantly from the expected equality, whereas they do differ sharply from the figures which would be expected on the basis of Table 2. The probability that they differ from the proportions of Table 2 by chance variation alone is less than 2 per cent. Evidently the squirrels are not affected by moonlight, as would be expected of diurnal animals.

Table 3. The same information, but grouped by ten-day periods, for the common diurnal forest squirrels, *Callosciurus notatus*, *C. nigrovittatus* and *C. caniceps*

Lunar dates	1–10	11–20	21–30
'Old'	11	9	8
'Young'	11	7	10
Total	22	16	18

$\chi^2 = 1{\cdot}43$. $P = 0{\cdot}5$.

During the same period, 284 pregnant house rats (*R. r. diardii*) were examined (Table 4). Here there is the same tendency as with the forest rats, but to a much lower degree. The probability that the difference from equality is due to chance is between 5 per cent and 10 per cent, a level of significance below the conventional standard. This result agrees with the suggested effect of moonlight, since house rats are, presumably, exposed to it far less than are forest rats.

It seems probable, therefore, that in the nocturnal rats the onset of the period of bright moonlight near the time of full moon has some stimulating effect on conception. There are, no doubt, other examples of this or related phenomena which I have not heard about. I should be most interested to know of any other observations which may provide some explanation of the phenomenon.

Table 4. The same information, by five-day periods, for the house rat, *Rattus rattus diardii*, from the town of Kuala Lumpur

Lunar dates	1–5	6–10	11–15	16–20	21–25	26–30
'Old'	23	30	20	24	26	19
'Young'	26	23	32	20	19	22
Total	49	53	52	44	45	41

$\chi^2 = 10{\cdot}3$. $P = 0{\cdot}07$.

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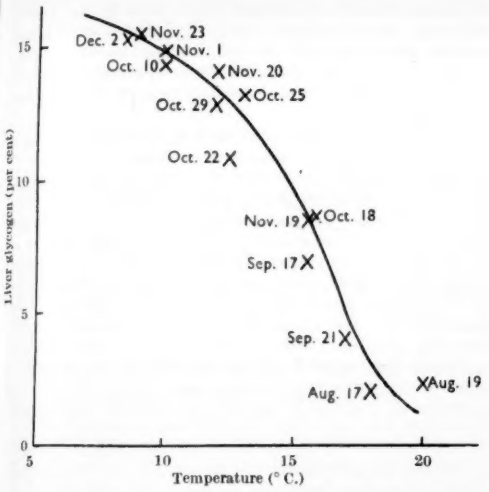
Environmental Temperature and the Glycogen Content of the Frog's Liver (*Rana temporaria*)

It has been generally concluded by previous workers that the glycogen content of the frog's liver in the autumn increases steadily as the season advances[1]. While this is probably true for the female, examination of the results for liver glycogen estimations made on fourteen samples which were caught between August and early December in 1948, 1949 and 1950, showed that this is not the case in the male frog.

Sometimes relatively low values were found in November and unexpectedly high concentrations in October. Some of these samples had been kept for three to five days in a tank-room at approximately atmospheric temperature, while others were actually killed in the field and the livers frozen in solid carbon dioxide for subsequent analysis in the laboratory. The temperature of the environment was recorded in each case, and it was found that when this was plotted against the mean glycogen content of the livers of the male frogs in the samples, the above-mentioned anomalies disappeared. This can be seen from the accompanying graph, where the observed points all lie reasonably close to a regular curve. Statistical analysis of the results shows a very significant correlation between glycogen content and temperature ($r = -0{\cdot}934$). From the graph it can be seen that the region of most rapid change lies between 12° and 17° C., as the slope of the curve decreases at lower temperatures. Glycogen attains its new level in the liver quite rapidly following a change of temperature. For example, on November 19, 1948, five male frogs were killed after being in captivity and unfed for three days. The temperature when this group was killed was 15·5° C. and the mean liver-glycogen content was $8{\cdot}5 \pm 0{\cdot}49$ per cent. On the following two days, when the average temperature had fallen to 10·5° C., six more males from the same sample gave a mean of $14{\cdot}4 \pm 0{\cdot}55$ per cent. Despite the small sample numbers, this difference is highly significant ($P < 0{\cdot}001$). The main temperature change occurred during the night of November 19, and the liver-glycogen content had reached its new level on the morning of November 20.

This relation between liver-glycogen content and temperature is apparently peculiar to the male and restricted to the period August to early December. In January, for example, a high glycogen content appears to be maintained despite a rise in temperature, unless precocious sexual activity supervenes, when the glycogen disappears quite rapidly even at low temperatures[1]. In the case of the female the amount of glycogen in the liver is low in August and September, and high in October, November and



Mean liver-glycogen content (percentage wet weight of liver) of male frogs, killed on the dates indicated, plotted against the temperature of the external environment

December, there being no obvious relation with the recorded temperatures. For example, in one September sample, the females contained 2·8 per cent liver glycogen at 15·5° C., while an October sample showed 9·5 per cent at 16·0° C. It would seem, therefore, that not only is the maximum glycogen content attained lower in the female[1], but also that it is not thermolabile.

It seems possible that the site of this action of temperature is at the level of the liver cells themselves, since adjustment of the liver-glycogen content takes place so rapidly. There may, however, be changes in the general endocrine system, perhaps of the type envisaged by Kepinov[2], occurring about the middle of August and December. A problem which still requires elucidation is the nature and source of the precursor of the not inconsiderable quantity of glycogen which appears in the livers of fasting male frogs without there being any regularly associated changes in the blood-sugar level. Experimental work on the action of temperature on glycogenolysis is at present in progress in this Department.

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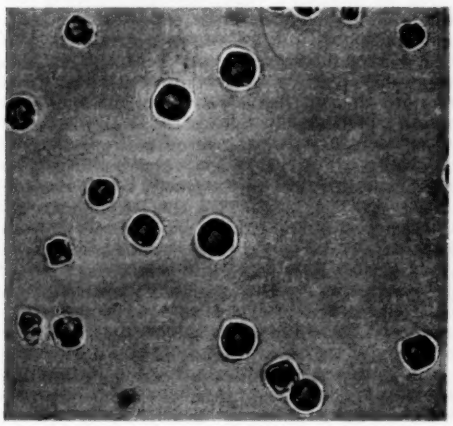
Presence of Ferritin in a Marine Elasmobranch, *Scyllium canicula*

Ferritin has been isolated in the crystalline state from various organs of man, horse, pig, jackal, rat, mouse and guinea pig. On the other hand, the characteristic crystals have not been obtained from the tissues of the ox, sheep, deer and chicken. In the liver and spleen of the latter animals there is present some non-hæmin iron and some ferric iron bound to a protein component; but no crystals of ferritin are obtained with cadmium sulphate. Data on the distribution of this protein on the zoological scale are not complete; since it has an important function in the metabolism of iron, knowledge of its presence in other organisms would be very valuable.

We have observed in the liver of a marine elasmobranch, *Scyllium canicula*, the presence of a protein containing non-hæmin iron. The iron is present as ferric iron reducible to ferrous, like that of ferritin, with sodium dithionite. Applying the technique of Granick[1], we have obtained dark red crystals in the form of octahedrons, isotropic under the polarizing microscope.



The liver was homogenized in a Waring blendor with two parts of water (w/v) because of the high content of glycerides. The crystals show the characteristics and properties of those of ferritin. Apart from the liver, we have also obtained the same crystals from the intestine, although we have not succeeded in obtaining them from the spleen, perhaps because there is too small a quantity. The presence of ferritin in the liver and intestine of this elasmobranch suggests that the metabolism of iron in this animal is analogous to that in the animals listed above. Attempts to obtain crystals from the liver of teleostean fish have proved unsuccessful.

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A New Species of the Mystacocaridea (Crustacea)

Among the numerous microscopic Crustacea brought back by the Lund University Expedition to Chile during 1948–49 was a new species of the sub-class Mystacocaridea, established by Pennak and Zinn[1] and recently discovered also in Europe by Chappuis, Remane and Delamare Deboutteville[2]. The species was obtained in the Pacific near the Island of Guafo in lat. 43° 33′ S., long. 74° 49′ W. on coarse sand in a depth of 25 m.

A comprehensive description of the new species, which belongs to the genus *Derocheilocaris* Pennak and Zinn, and its general anatomy, will appear in the reports of the expedition[3].

The head dorsally has what appears as a segmental border delimiting the part containing the protocerebrum (the so-called "rostral plate" of Pennak and Zinn) from the remainder of the cephalon. I consider this as a secondary development and not as a sign of a primitive segmentation of the acron (cf. refs. 4, 5). The antennæ, probably also the maxillulæ and the maxillæ, have a three-segmented protopodite, the mandible a two-segmented one. The occurrence in particular of two segments in the protopodite of the mandible—by far the most primitive found throughout the Crustacea—contradicts the opinion of Heegaard[6] that an unsegmented protopodite should be regarded as a primitive condition (cf. refs. 7, 8).

The nervous system is very primitive, although the peculiar position of the protocerebrum, deutocerebrum and tritocerebrum, which are widely separated, is probably due to the unusual shape of the acron. Anteriorly the acron is deeply cleft and each fronto-lateral projection carries two setæ, the nerve fibres of which can be traced to their entrance into the protocerebrum. On the lateral margins of the acron occurs one similar seta the nerve fibre of which can also be traced to the protocerebrum. The four anterior setæ are interpreted as probably representing the medial, originally unpaired, frontal organ, the nerve of which is always paired[9], the lateral ones as the paired (dorsal) frontal organ. There are generally two eyes of nauplius type at the base of each of the frontolateral projections, one situated more dorsally than the other. Probably the medial element of the nauplius eye has split into two which have gone one to each side together with the lateral element of the respective side. The splitting of the medial frontal organs and nauplius eyes is probably caused by the deep cleavage of the acron. The antennæ nerves come from the posterior part of the œsophageal commissure. The ganglion labrii is very large. Throughout the ventral nerve chain the longitudinal connectives are free. There is a free tritocerebral commissure and in each of the following segments a double free commissure is present. The ganglia touch in the medial line but without coalescing. The ventral chain is much more primitive than that of any other Crustacea excepting the Phyllopoda (for example, *Triops*) which it closely resembles.

The intestine resembles that of the Harpacticoida[10]. The stomodæum is very long and with a chitinous intima, the midgut begins in the hind part of the cephalothorax with an area with large, apparently secretory cells and is short and wide; the proctodæum occupies at least half the length of the abdomen. No cæca were observed.

The sexes are separate as in the European species[2]. In both sexes I have found the genital pore on the ventro-lateral side of the fourth segment (counting the maxilliped segment as 1), that is, I have seen the opening in the hypodermis but found no external pore. I have never seen more than one gonoduct and in three males and two females investigated it opens on the right side. The "yolk sac" of Pennak and Zinn, interpreted by Armstrong[11] as a spermatheca, undoubtedly represents a vitellarium. The yolk in immature females is formed by disintegration of cells probably from the posterior part of the ovarium. In mature females it is filled by eosinophile granules and surrounded by a membrane. The eggs, which are few and large, are obviously nourished by means of diffusion of dissolved substances. The testes are very large, occupying most of the dorsal part of the male thoraco-abdomen. Although there is only one ductus deferens, the testes are obviously of a paired origin and are provided with two longitudinal series of broad lobes. Sperm is produced in large quantities. There are no spermatophores. No copulatory organs have been observed.

With Pennak and Zinn[1] and against Armstrong[11], I maintain that *Derocheilocaris* cannot be referred to the Copepoda, but that a taxonomical group of the same order as the Copepoda must be created for it. The Entomostraca being ruled out as a natural group, the Mystacocaridea will obtain the status of a sub-class. From their nearest relatives, the Copepoda, they differ mainly in the greater primitiveness of the mouth parts, the location of the genital pore, the primitive structure of the genital organs and the nervous system. With regard to the latter organ systems, they approach the Phyllopoda or, rather, a generalized primitive Crustacean type. In several respects they are more advanced than the Phyllopoda.

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Amino-acids in Legumes

In the course of analyses of vegetable foods with the view of evolving an entirely vegetable dietary which would be optimal in respect of protein, determinations of essential amino-acids were carried out on two legumes, Mysore dhal or lentil (*Lens esculenta*), and green gram or mung (*Phaseolus vulgaris*, Roxburgh). The determinations were carried out by microbiological assay. *Leuconostoc mesenteroides* and *Streptococcus fœcalis* were used with various media[1] in the assay of lysine, methionine, *iso*leucine and phenylalanine, and *Streptococcus fœcalis* in the assay of valine, leucine and threonine.

In view of current interest in the substitution of vegetable products for animal foods in nutrition[2], this preliminary communication may be of interest. Figures for *Phaseolus vulgaris* L. and soya bean calculated from published data are included for comparison.

Essential Amino-acids in Legumes
(Figures given are amino-acid nitrogen as percentage of total nitrogen)

Amino-acid	*P. vulgaris* L. (ref. 3)	Soya bean (ref. 4)	Lentil	Green gram
Lysine	7·2	7·9	7·9	8·7
Threonine	3·7	2·8	2·7	2·6
Methionine	0·4	0·8	0·4	0·7
*iso*Leucine	—	3·4	3·2	3·2
Leucine	8·8	5·1	4·6	5·2
Valine	4·0	4·0	4·1	4·3
Phenylalanine	2·9	2·7	2·6	2·7
Tryptophane	0·9	1·1	—	(1·1) (ref. 5)

Details of these investigations will be published elsewhere.

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Serological Properties of Human Blood Group *A* and *B* Substances

During the course of the isolation and characterization of the human blood group *B* substance from some ovarian cyst fluids, it was observed that certain fractions of the mucoid materials obtained were relatively inactive in the usual iso-agglutination inhibition tests using naturally occurring β-agglutinin. The materials were, however, found to possess high activity when similarly assayed against human immune anti-*B* sera, which arose as a consequence of an incompatible transfusion or as a direct result of immunization with human group *B* substance or through an injection of horse serum. Rabbit immune anti-*B* sera which were produced by means of an artificial antigen made from human blood group *B* substance, and the serum of a chicken which contained a potent anti-*B* agglutinin after immunization with *Shigella shigæ* and absorption with *O* and *A* cells, were also found to behave as did the human immune anti-*B* reagents. In these experiments, in which saline alone was used as diluting medium, all materials which inhibited the naturally occurring β-agglutinin also inhibited the immune anti-*B* sera.

The *B* substances in the *AB* materials isolated from three cyst fluids obtained from 'secretors' belonging to group A_1B behaved as did the selected mucoid materials mentioned above, and were found to possess negligible activity when tested with natural β-agglutinin but were highly active when tested against immune anti-*B* sera.

Materials with these restricted serological characters can be produced artificially from an essentially homogeneous human group *B*-substance (nitrogen, 5·8 per cent; fucose, 18 per cent; hexosamine, 20 per cent), which inhibits, at a dilution of 1 in 10^6, two to three completely agglutinating doses of either the natural β-agglutinin or the immune anti-*B* sera, by heating in an autoclave a 1 per cent solution of the purified *B*-substance in borate buffer (*p*H range 7·7–8·0) at 120° for about 45 min. Other weakly alkaline buffers within this *p*H range can also be employed. The *B* substance in fresh human saliva is similarly changed serologically after heating under these conditions.

The modification in serological properties of a group *B* substance which before treatment reacts with both natural and immune anti-*B* agglutinin is associated with a loss of viscosity and with the development of a capacity to give an 'N-acetylglucosamine' colour when treated with Ehrlich's reagent[1]. After heating under the conditions described, about 20 per cent of the material is found to diffuse through a 'Cellophane' membrane, and the diffusible material contains the whole of the chromogen and shows the changed serological character. The chromogen is not associated with the serological activity, however, since it is soluble in ethanol whereas the serologically active component of the diffusate is insoluble in this solvent. The indiffusible portion of the mucoid is found to possess a somewhat higher nitrogen and L-fucose content than the original material. Both the serologically active diffusible and indiffusible components react weakly or not at all with natural β-sera but show full activity when tested against immune anti-*B* agglutinin.

The serological specificities of human β- and rabbit anti-*B* sera have been studied in considerable detail[2], and it appears that human β-agglutinin contains two components, β_2 and β_3 and sometimes a third agglutinin designated β_1. Human group *B* erythrocytes contain receptors B_1, B_2 and B_3 corresponding to the three kinds of agglutinin, whereas rabbit red blood cells possess the specific receptors B_2 and B_3 only, and therefore in this species β_1 agglutinins alone can be formed. We have examined, by the methods of Friedenreich and With, some of our natural and immune human sera and have found that, regardless of whether or not our natural sera contain β_1, they are not inhibited by the selected mucoid materials or by the artificially modified *B* substance. The results suggest that the serological behaviour observed for the *B* substances is not related to the agglutinins β_1, β_2 and β_3 but is associated in some way with the normal or the immune character of the agglutinin. By postulating a further 'partial receptor' in the *B* specific complex, the antibody to which is found in human immune and animal immune sera only, our observations can be brought into line with the earlier views. This additional partial receptor is presumably more stable to the action of alkali than are the structures associated with the characters B_1, B_2 and B_3.

We have examined the activity of the two types of *B* material by means of the normal β-agglutinins obtained from persons belonging to groups A_1, A_2 and *O* and from an individual believed to be A_4. In one instance only, of twenty-one sera tested, did the anti-*B* agglutinin behave as an immune agglutinin, and it was afterwards found that the individual from whom this serum was obtained had received repeated injections of T.A.B., A.T.T., anti-typhus and anti-yellow fever vaccine. Thus it would appear that the differences in the heat of the antigen–antibody reaction reported by Wurmser, Armand and Wurmser[3], and believed by them to be related to the *ABO* genotype of the person producing the antibody, are apparently not associated with the differences in the reactivity of the natural and immune agglutinin described by us.

The examination of the behaviour of human *A* substance before and after treatment at *p*H 8 and 120° for different periods of time up to 45 min. revealed no definite differences in the behaviour of the materials with natural and immune anti-*A* agglutinins when A_1 cells were used in the inhibition test. After a longer period of heating, the *A* activity was considerably reduced or completely destroyed, and when the activity was destroyed for one anti-*A* serum it was destroyed for all the other sera examined. The replacement of A_1 cells in the test by A_2 cells, a procedure considered to increase the sensitivity of the test for the detection of *A* character[4], revealed that materials which possessed little or no activity

when A_1 cells were used were fully active in the presence of A_2 cells. These results were obtained when both normal and immune anti-*A* agglutinins were used in the inhibition tests.

The *A* substance in the three active A_1B cyst fluids reported above appears to be of the type which shows low activity when examined in inhibition tests using A_1 test cells. Assayed against the same sera but using A_2 cells, the material showed considerable activity. Materials which possess a serological behaviour similar to that induced by heat treatment of fully active *A* substance can therefore be encountered in native cyst fluids[4].

These results indicate clearly the importance of examining serologically preparations of blood-group *B* substance or their partial degradation products, with both natural and immune group agglutinins, before concluding that the original serological specificity has been completely lost. Similarly, inhibition tests made to determine the activity of *A* preparations should employ A_2 as well as A_1 test cells. By these means important differences in the serological characters of preparations of the *A* and *B* substances can be revealed. The effect of different reagents, including enzymes, on the purified substances is being examined in greater detail in the light of these findings and will be reported elsewhere.

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A Relationship between the Secretion of the Blood Group Antigens and the Presence of anti-O or anti-*H* in Human Serum

Human and animal sera exist which agglutinate red blood cells of group *O* and A_2 more strongly than those of other groups; these have been known for many years as anti-*O* sera. In 1948 Morgan and Watkins[1] divided such sera into two kinds: those which could be inhibited by saliva from secretors of all A_1 A_2 *B O* groups, anti-*H*, and those which could not be inhibited, anti-*O*. Both types are found in human serum.

In this Unit it has been felt for some time that, apart from this clear distinction, the two types of antisera are indistinguishable in their reaction with red cells of the different *ABO* and *Lewis* groups. It occurred to me that one antibody (anti-*H*) if developed in a non-secretor person might be susceptible to inhibition *in vitro* by 'secretor' saliva, while the same antibody (anti-*O*) if developed in a secretor person might be immune to inhibition.

No information about the saliva of donors of anti-*O* and anti-*H* sera was available to test this possibility; there was, however, information about their *Lewis* groups, and these groups, as Grubb[2] and subsequent workers have shown, are closely correlated with secretion of the *A*, *B* and *H* antigens in the saliva. (All *Le*(*a*+) persons so far tested are non-secretors, and more than 98 per cent of *Le*(*a*−) people are secretors[3].)

Miss E. W. Ikin and Dr. A. E. Mourant very kindly provided fifteen samples of undifferentiated anti-*O* or anti-*H* sera, together with the *Lewis* groups of the donors. These sera, together with four others, were then classified by inhibition tests with saliva from secretor persons of group *O*. In each case, saliva from non-secretor persons of group *O* was used as a control. Details of two further examples of anti-*H* were kindly provided by Prof. Morgan[4]. The total count is:

		Red cells of donor	
		Le(*a*+)	*Le*(*a*−)
Antibody in serum of donor	anti-*H*	8	0
	anti-*O*	1	12

The probability that this lack of proportion is due to chance is 1 in 22,610.

Since 22 per cent of Europeans are *Le*(*a*+), the disturbance is mainly in the top row of the 2 × 2 table; from these results it would seem that when anti-*H* is made it is made by *Le*(*a*+) people.

Conversely, it may be that anti-*O* is usually made by *Le*(*a*−) persons, though the existence of the exception shows that this is not always so. The collection of sufficient data to show any significant disturbance in the second row of the 2 × 2 table may take a long time, for much larger numbers of donors of this rather rare serum, anti-*O*, will be needed.

It is difficult to imagine that the presence of the *Le*(*a*+) character on the red cells determines that the antibody in the serum is to be anti-*H*; the decisive factor is more likely to be the non-secretor environment in which the antibody is made.

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Acetylcholine Esterase of the White Components of Blood

A paper by Zajicek and Datta[1] describing the presence of a high concentration of acetylcholine esterase or 'true' cholinesterase in the thrombocytes of rat blood recently came to my attention. I have known for some time that considerable 'true' cholinesterase is to be found in the white layer of centrifuged rat blood, and while I was working at the Medical Research Laboratories of the Defence Research Board, Ottawa, Canada, I showed by substrate and inhibitor studies that this is a typical 'true' cholinesterase. It was my opinion at that time that the enzyme was in the leucocytes rather than in the platelets; but in all other respects my work with rat blood confirmed the findings of the above authors.

After coming to England, I extended these observations to other species and found that the enzyme was present in very high concentration in the white layer of centrifuged mouse blood which consisted almost entirely of platelets, and in the same layer of cat blood; but I have not found any comparable activity in the white layer of the blood of man, or

in that of the ox, sheep, pig, dog, rabbit or guinea pig. Species differences are characteristic not only of the true enzyme, but also of the 'pseudo' cholinesterase[2]. If the enzyme has any real function, it is difficult to understand what takes its place in the organs or cells of those species in which there appears to be no activity.

I am now making investigations to find out where the enzyme is localized in the active bloods, and if any function can be assigned to it.

I should like to acknowledge the help and encouragement of Dr. M. L. MacFarland, of the Defence Research Medical Laboratories, Ottawa, who supervised the research done in Canada, and of Prof. R. A. McCance, under whose direction the work is being continued in Cambridge.

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Retinal Colour Processes caused by Intermittent White Light

It is a well-known fact that colour sensations can be produced by intermittent white light (the so-called subjective colour phenomenon of Fechner[1] and Benham[2]). This phenomenon has been investigated by us by means of a physiological method described in detail in a previous paper[3]. The electrical sensitivity of the dark-adapted eye was measured at varying intervals after exposure for 2 sec. of the central fovea to a pre-illuminating patch of 1° in visual angle. After removal of the light stimulus, the excitability recovers very rapidly, becomes supernormal and then decreases to the initial level. The maximum of supernormality lies at 1, 1·5, 2 and 3 sec. when red, yellow, green and blue lights are used for pre-illumination. The broken curves in Fig. 1 are examples of excitability curves for white light, which have a maximum at about 2 sec.

The curve for white light is increased in height and shifted to the right when yellow light is presented prior to the white light. Since this curve is similar in shape to that for blue light, the successive stimuli,

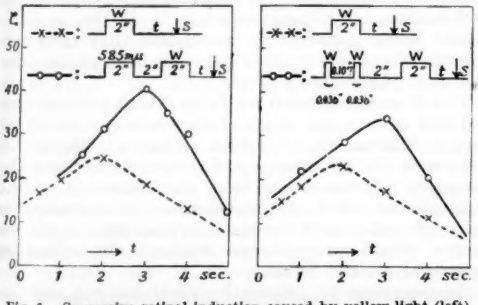

Fig. 1. Successive retinal induction caused by yellow light (left) and by two flashes of white light (right). Ordinates: percentage increases in electrical excitability of the eye over its resting level. Abscissæ: time in sec. from the end of white light lasting 2 sec. Experimental procedure is shown in insets, where *W* represents white light of 70 lux, *S* an electric stimulus of 0·1 sec. in duration, *t* variable interval between *W* and *S*. Intensity of flashes was 120 lux

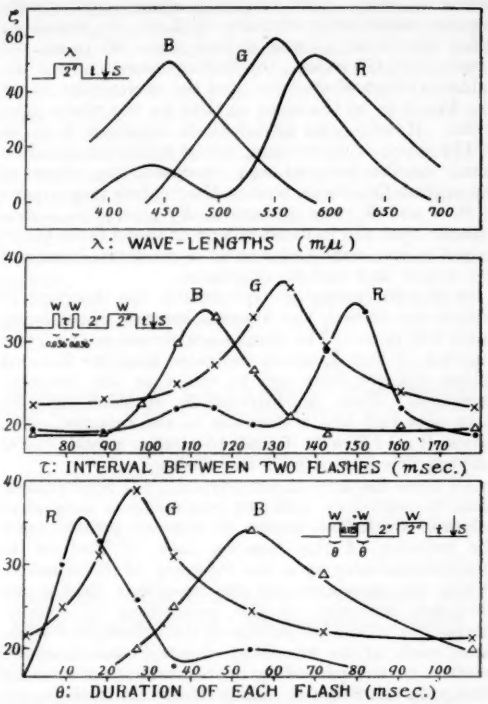

Fig. 2. Response curves for an equal-energy spectrum (upper diagram) and those for intermittent white light (middle and lower diagrams). Experimental procedure is shown in insets, in which τ and θ represent variable interval between two flashes of fixed duration 0·036 sec. and variable duration of flashes delivered at a fixed interval 0·125 sec. respectively

yellow and white, may be taken as equivalent to a blue light stimulus. A group of such phenomena has been studied extensively in a previous paper[4] and termed 'retinal colour induction'.

In the present investigation, it was found that two flashes of white light adequately spaced may be used as a substitute for the yellow light used in the experiment mentioned above. The curve obtained in this way is materially different from that for white light alone, showing a maximum at about 3 sec. just like a curve for blue light (Fig. 1). By varying the interval between two flashes, but under otherwise precisely the same experimental conditions, we succeeded in realizing effects of colour induction similar to those caused by spectral lights of various wave-lengths. In Fig. 2 it is demonstrated how this phenomenon depends on the interval between two flashes. For comparison, response curves for an equal-energy spectrum are illustrated in the upper diagram, in which data of electrical excitability at 1, 2 and 3 sec. after illumination are denoted by *R*, *G* and *B* respectively and plotted against the wave-lengths of pre-illuminating spectral lights. For reasons stated in the previous papers[3], the quantities *R*, *G* and *B* represent excitation of red, green and blue receptors respectively. It is to be noted that these response curves, determined by our physiological method, bear a striking resemblance to the fundamental sensation curves obtained by previous workers[5-7] from their colour-mixing experiments. The response curves shown in the middle diagram were obtained in the manner stated above, using two

flashes of white light variously spaced and a subsequent white light stimulus of 2 sec. in duration. When the interval was shorter than 90 m.sec. or longer than 170 m.sec., the flashes showed no colour-inducing effect whatsoever, and the excitability curve was found to be the same as that for the white light alone. However, at intermediate intervals from 90 to 170 m.sec., very striking colour induction could be seen; as the interval was increased, the shape of the excitability curve, that is, the relative magnitudes of R, G and B, were systematically altered in such a manner that the induced colour changed from violet to red in the same order as in a spectrum (compare the upper and middle diagrams).

In another series of experiments the duration of flashes was varied, the interval between them being made 125 m.sec. The results are shown in the lower diagram of Fig. 2, which indicates that the induced colour changes from red to violet as the duration increases. Thus, an increase in duration of each flash acts just like a decrease in the interval. The ratios $R : G : B$ were found to change greatly upon varying the intensity of the flashes.

All these features of our physiological observations seem to reproduce well the properties of subjective colours, which are known to depend greatly upon the velocity of the rotating disk of Fechner or Benham and also upon the intensity of illumination. While the properties of the preceding flashes are obviously essential to the production of colours, alterations of the properties of the subsequent white light, such as its intensity, duration and temporal relation to the preceding flash produce no essential change in the results; colour effects can be seen even without the subsequent white light. It merely serves to turn colours caused by flashes into their complementaries.

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Vitamin A Ester and Vitamin A Alcohol in the Serum of the Œstrogenized Immature Pullet

The vitamin A of mammalian sera appears to be present principally as the alcohol, whereas the vitamin A of the liver is present mainly in ester form. As regards avian species, Neff *et al.*[1] have shown that the vitamin A of hen's egg yolk is present largely as the alcohol. Parrish *et al.*[2] have shown that the alcohol of the yolk is transformed in part to ester during incubation, and that the ester is the principal form in the livers of newly hatched chicks.

Administration of œstrogen greatly increases the level of vitamin A in the sera of immature pullets[3]. The state in which this extra vitamin A exists in the sera of œstrogenized pullets has now been examined. Sera have been collected from control and œstrogenized immature pullets in experiments undertaken for other purposes. These sera have been analysed for vitamin A by drying suitable samples by grinding with anhydrous sodium sulphate, extracting with petroleum ether and analysing the extract by the chromatographic technique of Narod and Verhagen[4].

The relevant results for two sets of observations are presented in Tables 1 and 2. The results for the control groups indicate rather low total vitamin A values, possibly due in part to comparative inefficiency of direct extraction with petroleum ether as compared with saponification and separation of the vitamin with the unsaponifiable.

Table 1. Effect of Œstradiol Benzoate on Serum Vitamin A Alcohol and Serum Vitamin A Ester of the Sexually Immature Pullet (New Hampshire ♂ × Barred Plymouth Rock ♀). Average Results

Duration of experiment, 14 days. Hormones given by intramuscular route. Age of pullets at end of experiment, 74 days. All birds received same amount of food

Group	*E*	*F*
Number of pullets	5	5
Dosage œstradiol benzoate (mgm.)	nil	7 × 1·5
Dosage testosterone propionate (mgm.)	nil	7 × 1
Oviduct weight (gm.)	0·22	22·9
Serum vitamin A alcohol (μgm./100 ml.)*	3·3	2·6
Serum vitamin A ester (μgm./100 ml.)†	1·3	30·8
Serum vitamin A total (μgm./100 ml.)†	4·6	33·4

* Diff. not significant. † Diff. highly significant ($P < 0·01$)

Table 2. Effect of Gonadal Hormones on Serum Vitamin A Alcohol and Vitamin A Ester of Sexually Immature Pullets. (New Hampshire ♂ × Barred Plymouth Rock ♀). Average Results

Duration of experiment, 12 days. Hormones administered intramuscularly on alternate days. Age of pullets at end of experiment 89 days. All birds received same amount of food.

Group	*A*	*B*	*C*	*D*
Number of pullets	6	5	6	5
Dosage œstradiol benzoate (mgm.)	nil	nil	6 × 1	6 × 1
Dosage testosterone propionate (mgm.)	nil	6 × 1	nil	nil
Dosage progesterone (mgm.)	nil	nil	nil	6 × 1
Serum vitamin A alcohol (μgm./100 ml.)*	4·2	4·1	4·0	3·9
Serum vitamin A ester (μgm./100 ml.)†	0·9	2·2	42·8	47·5
Serum vitamin A total (μgm./100 ml.)†	5·1	6·3	46·8	51·4
Serum calcium (mgm./100 ml.)†	11·7	11·4	71·3	72·3

* Diff. between groups not significant.
† Diff. between groups *A* and *B* and between *C* and *D* not significant. Other differences highly significant ($P < 0·01$).

The results, however, provide fairly strong evidence for the conclusion that the increase in serum vitamin A of the immature pullet evoked by œstrogen is largely, if not entirely, an increase in vitamin A ester fraction. If the effect of œstrogen on serum vitamin A operates as a mechanism for the direct mobilization of hepatic vitamin A to the yolk, it would seem plausible to anticipate that œstrogen would enhance the level of the ester form rather than the level of the alcohol form.

It will be remarked from Table 2 that progesterone did not reduce the effect of the œstrogen on either serum vitamin A or serum calcium, although it depressed the hypertrophy of the oviduct evoked by œstrogen. Hertz *et al.*[5] have also remarked on the insignificant effect of progesterone on the response of serum calcium of the chick to œstrogen in experiments where progesterone reduced the effect of œstrogen on the oviduct.

Testosterone propionate by itself did not significantly affect serum vitamin A, a point which has already been noticed in this laboratory[6]. It is of interest to record, however, that testosterone propionate by itself may significantly increase serum carotenoids[6] although not affecting serum vitamin A.

We are indebted to Messrs. Schering Corporation, Montreal, for generous gifts of hormones.

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Absorption from Intestine of Rats with Blind Self-filling Pouch

IT has been shown by Watson, Cameron and Witts[1] that macrocytic anæmia develops in rats in which a blind self-filling intestinal pouch has previously been formed. They were unable[2], however, to demonstrate any anatomical or histological lesion in the alimentary tract. Toon[3] found that treatment with aureomycin prevented the appearance of anæmia in 100 per cent of rats, adding weight to Witt's suggestion that the anæmia might be due in some way to the bacterial content of the pouch. Nevertheless, Aitken, Badenoch and Spray[4] found a deficiency in fat absorption in rats so operated, whether or not anæmia had developed.

It was thought that it might be of interest to study the absorption of glucose and an amino-acid from the intestine of rats treated thus.

Blind self-filling pouches were formed, as described by Cameron, Watson and Witts[1], at approximately 40 cm. from the ileo-cæcal valve and of approximately 15 cm. in length. The animals were fed on ordinary diet throughout. The acute experiments were carried out eight to ten weeks after operation, since it was found that at this time the hæmoglobin had fallen from the normal 100–110 per cent to an average of 80 per cent (Haldane). In one set of experiments, absorption of glucose in operated rats was compared with that in a group of normals; absorption of L-glutamic acid was compared in a further series of operated and normal rats.

Intestinal loops were prepared as described by Gibson and Wiseman[5]. In operated animals, these were formed just proximal to the orifice of the cul-de-sac, and in normal animals at a corresponding distance from the ileo-cæcal valve. In the first series, 1 ml. of glucose solution containing 100 mgm. was administered and the sugar content of the fluid in the loop estimated after 1 hr., by the method of Nelson[6]; in the second series, 1 ml. solution containing 37·8 mgm. L-glutamic acid (sodium salt) was administered and the loop fluid analysed again after 1 hr., by the method of Pope and Stevens[7].

In neither set of experiments was there any significant difference in absorption between normal and operated rats. In the glucose experiments, normals showed a mean absorption of 68·4 mgm./hr. compared with 67·3 mgm./hr. for operated animals; the standard error of the difference was ± 9·1. In the glutamic acid experiments the figures were 27·4 and 27·0 mgm./hr. respectively, the standard error of the difference being ± 2·0. The variability was such as not to be appreciably affected by the fact that not all loops as finally measured were exactly 15 cm. long. There was no correlation between absorption and weight of rat, or—in the case of operated animals—alteration in weight.

The above experiments, then, provide no evidence that the absorption of glucose and glutamic acid from a blind self-filling intestinal pouch is significantly different from that from normal intestine.

I am indebted to Miss M. Creasy, of the Department of Statistics, University of Aberdeen, for the statistical analysis.

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Thin-Film Interferometric Techniques for High-Magnification Topographical Studies

THIS communication describes a simple interferometric technique for examination of surface topography without the use of optical flats, the particular advantage being the possibility of using high magnification in extension across the surface without the use of a complex interference microscope. The techniques are based upon the production of a thin transparent film of Canada balsam on the surface. A drop of Canada balsam dissolved in benzine is placed on the surface and, after spreading, dries as a thin film. The spreading is assisted by a touch of cedar wood oil. The thin film appears to follow closely the contour of the lower surface, while taking on a reasonably flat upper surface, although wrinkling can at times be detected. Illumination with monochromatic light leads to the production of an interference picture which exhibits some degree of multiple-beam interference and, as the film is very thin, high resolution, using up to 3-mm. dry objectives, can be used. Thus it is possible to examine interferometrically with simultaneous high magnification in extension, a condition not normally realizable with a multiple-beam equipment employing optical flats.

The wrinkling or curvature of the surface of the film, which is irrelevant to the topography under study, restricts the application of the method largely to the study of discontinuities, at which any spurious topography due to surface curvature does not invalidate conclusions drawn as to the heights of the discontinuous steps. Order allocation is readily obtained by using different wave-lengths, and the direction of the steps by arranging the surface film to be wedged in a suitable direction. The method has the merit that it can be used on relatively inaccessible regions of crystals.

Fig. 1 (× 600 in extension) shows growth steps on a silicon carbide crystal. Fig. 2 (× 1,800 in extension) shows the interferogram given by growth trigon on a natural (111) diamond octahedron face. This is of considerable interest in that it reveals a 'trench'

Fig. 1 (× 600)

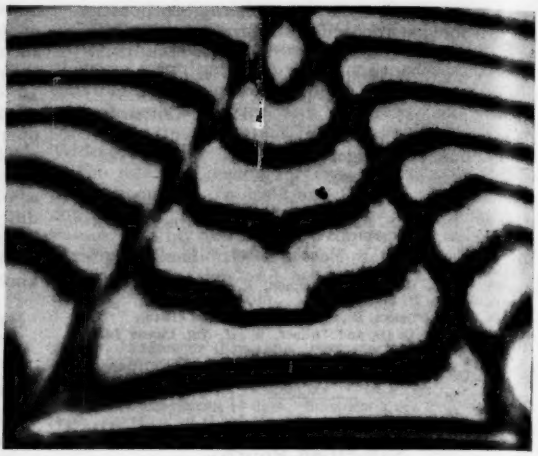

Fig. 2 (× 1,800)

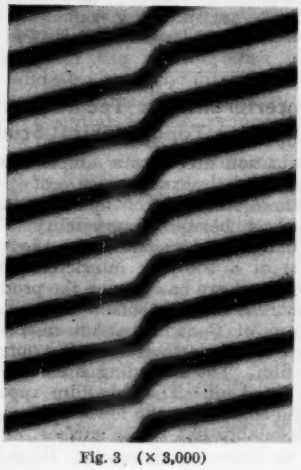

Fig. 3 (× 3,000)

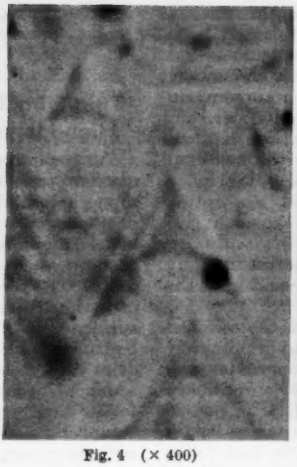

Fig. 4 (× 400)

Fig. 5 (× 400)

surrounding the trigon about half a light-wave in depth. Fig. 3 (which contains, of course, a good deal of empty magnification) shows, at × 3,000, a growth step on the surface of a hæmatite crystal, and the main feature of interest here is the fact that the step edge is shown distinctly not to be vertical but to be at an angle of some 4·4°, a feature which could not be revealed by multiple-beam methods.

In a second method of using the thin-film technique, the Canada balsam is pulled by an oil drop at the edge of the specimen before setting, under which conditions a thin film of almost uniform thickness can be obtained on a reasonably flat surface. On illumination with an unfiltered mercury arc, or white light, high interferometric contrasts appear and a wealth of detail is revealed, the system operating not as a topographical measuring device but as an enhancer of contrast, particularly to the eye, which is so sensitive to colours. Fig. 4 (× 400) shows a region of the surface of a diamond photographed by ordinary means. Fig. 5 is the interferometric contrast picture. A phase-contrast micrograph of the same region does not reveal much more than is shown by this simple interferometric device.

Finally, it is possible to use multiple-beam methods by first silvering the crystal, depositing the film and then silvering the film, but so sensitive does the method become and so extremely narrow are the fringes that especial care must be taken to avoid wrinkling.

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M. Omar

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March 28.

Photo-Elastic Determination of Boundary Stresses

Although several methods have been used for the photo-elastic determination of stresses at a free boundary, none has proved satisfactory because these methods are based on an extrapolation procedure which cannot be applied to a region where the magnitudes or directions of the stresses are rapidly changing. The following method permits a much closer approach to the solution of boundary stresses.

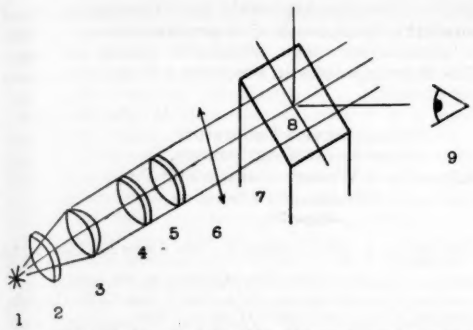

Fig. 1. Apparatus for the photo-elastic determination of surface stresses. 1, High-pressure mercury lamp; 2, heat-absorbing filter; 3, collimating lens; 4, green filter; 5, polarizer; 6, plane of polarization; 7, stressed model; 8, surface region; 9, observer

It is known that the components of a ray of polarized light traversing a stressed plastic model (of suitable material) will suffer relative retardations which are proportional to the maximum effective shear stresses in the path of the ray. These retardations may be seen in the form of interference fringes by viewing the ray through a second polarizer (analyser). Ordinarily, the analyser has been an element (Nicol prism, 'Polaroid', etc.) separate from the model, or use has been made of polarization due to scattering by particles within the model. In the present method for the determination of the stress at a point in the surface of the model, the surface itself is utilized as the analyser. To achieve this, the surface must be left in an as-machined condition, that is, unpolished.

A collimated beam of polarized light is projected through a section of the stressed model which includes the surface region under investigation. The model is aligned so that the tangent plane at the surface point is parallel to the direction of the beam. The plane of polarization of the beam should be adjusted to form an angle of 45° with the tangent plane. As the beam penetrates the model, the rays of the beam inside and adjacent to the surface will graze the tiny surface irregularities. Polarization by reflexion or refraction at these irregularities will result in the surface performing the function of the analyser. If the surface region is viewed from a position perpendicular to the direction of the beam and at an angle of 45° to the tangent plane of the surface point, an interference fringe pattern will be visible. The spacing of the fringes is inversely proportional to the effective shear stresses. It is possible to obtain the principal stresses by taking measurements for three orientations of the surface to the direction of the beam.

A simplified arrangement of the apparatus is shown in Fig. 1. It is usually necessary to immerse the model in a glass tank containing a clear liquid of the same refractive index as the plastic. This procedure reduces the refraction that would otherwise occur at the face of the model. To ensure that the surface fringe pattern will not be obscured by light scattered within the model, a material such as 'Catalin' with negligible scattering properties should be employed. As an illustration of a fringe pattern obtained by this method, a photograph of the tension surface of a beam in pure bending is shown (Fig. 2).

Direction of beam ↓

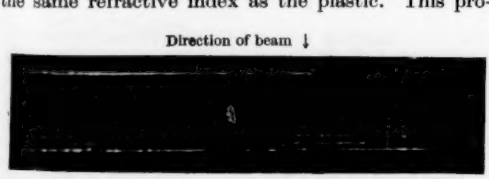

Fig. 2. Surface fringe photograph of the tension edge of a beam in pure bending

Several applications of this technique are now under investigation here.

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Nov. 15.

Effect of Scopoletin on Indoleacetic Acid Metabolism

SCOPOLETIN is a normal constituent of many plants and is responsible for the blue fluorescence of oat roots[1]. An accumulation of this substance has been observed in tobacco[2] and potato[3,4] plants suffering from certain virus diseases, in topped tobacco[5] and in plants treated with 2,4-dichlorophenoxyacetic acid[6]. When applied to the growing tip of oat rootlets, it was found to be the most active of all the coumarin derivatives tested in causing inhibition of root growth[7]. Coumarin is believed to exert its effect by combining with sulphydryl enzymes concerned with growth[8].

In the presence of potato tissue, scopoletin is oxidized to a blue intermediary which turns yellow on standing. This reaction is inhibited by cyanide, azide, hydroxylamine and accelerated by hydrogen peroxide[3]. During the present work it was observed that the oxidation was also inhibited by diethyldithiocarbamate and manganous ions, but was not affected by carbon monoxide either in the light or dark. The *p*H optimum lay between *p*H 6·0 and 6·6. The properties of the scopoletin oxidase appeared to be so similar to those described[9–11] for indoleacetic acid oxidase that it seemed possible that the two were identical. In support of this concept, it was found that indoleacetic acid oxidase extracts prepared by the method of Galston *et al.*[9] actively destroyed scopoletin in the light (Fig. 1) and less actively in the dark. Scopoletin was determined fluorometrically. The colour changes brought about by indoleacetic acid oxidase extracts and scopoletin were identical with those obtained with potato tissue.

While indoleacetic acid did not inhibit the metabolism of scopoletin, scopoletin inhibited the destruction of indoleacetic acid by the oxidase (Fig. 1). The decrease in inhibition with time is attributed to the disappearance of scopoletin from the reaction mixture, since high concentrations or repeated small additions of scopoletin prolonged the period of inhibition. In the absence of the enzyme, scopoletin had no effect on indoleacetic acid, which was determined colorimetrically by the method of Tang and Bonner[10].

By applying the procedure of Lineweaver and Burk[12] to the results, it was found (Fig. 2) that scopoletin acts as a competitive inhibitor. It thus appears either that scopoletin is oxidized by a similar

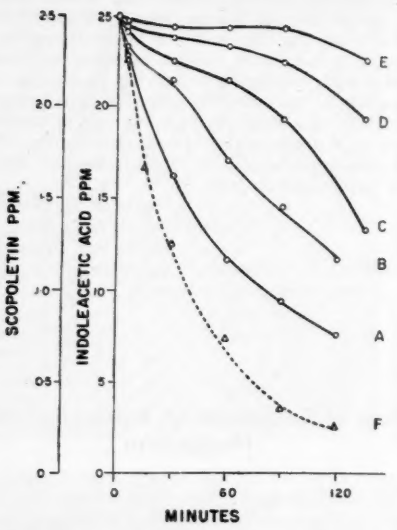

Fig. 1. Effect of scopoletin on destruction of indoleacetic acid by indoleacetic acid oxidase. *A*, no scopoletin; *B*, *C*, *D*, *E*, 2·5, 4, 12, 25 p.p.m. scopoletin respectively; *F*, scopoletin loss in reaction mixture containing 2·5 p.p.m. scopoletin

but different enzyme and competes for hydrogen peroxide, or that the two enzymes are identical and that scopoletin is preferentially attacked. Tang and Bonner[10] showed that *cis*- and *trans*-cinnamic acid and nine other analogues and auxin-like compounds had no appreciable action on the oxidase; we found coumarin also to be ineffective, so that it is not apparent why scopoletin, which is related to the cinnamic acids and to coumarin but not to indoleacetic acid, should show a competitive action.

If scopoletin behaves similarly *in vivo*, then it should simulate an auxin when applied to plants by its auxin-sparing action. It was found that the root-growth of peas soaked in 50 p.p.m. scopoletin prior to germination was temporarily retarded, while soaking in much weaker solutions (1 p.p.m.) resulted in a stimulation. This is analogous to the results of Thimann[13], who observed stimulation of root growth with low concentrations of auxin and inhibition with

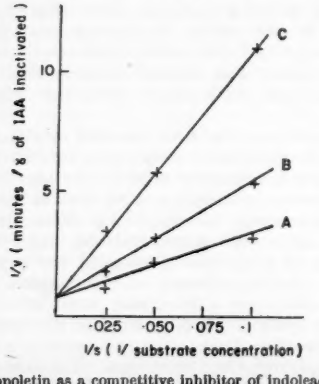

Fig. 2. Scopoletin as a competitive inhibitor of indoleacetic acid by indoleacetic acid oxidase. Loss of indoleacetic acid was determined after 20 min. in reaction mixtures containing the oxidase and 10, 20, 40 p.p.m. of the acid in the absence (*A*), and presence of 2 p.p.m. (*B*), and 6 p.p.m. (*C*) of scopoletin

higher. Presumably with low concentrations of scopoletin, indoleacetic acid accumulates only within the stimulatory range, while with higher concentrations it accumulates in amounts sufficient to depress root growth.

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Jan. 31.

[1] Goodwin, R. H., and Kavanagh, F., *Bull. Torrey Bot. Club*, **76**, 255 (1949).
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[11] Wagenknecht, A. C., and Burris, R. H., *Arch. Biochem.*, **25**, 30 (1950).
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Adsorption of Amino-acids on Sparingly Soluble Inorganic Solids

Among chromatographic adsorbents there is continually in progress a search for substances of higher adsorbing capacity and/or increased selectivity of adsorption. We have found that a number of sparingly soluble inorganic solids exhibit a small but definite binding affinity for amino-acids, and have attempted to relate such adsorption to certain physical properties of the adsorbent. The electrokinetic properties of both natural and artificial samples of several such solids have been investigated[1], and from these results it could be expected that such differences would be reflected in comparative affinities for binding amino-acids. Such has been found to be the case for the two amino-acids discussed here, namely, aspartic acid and glycine.

Solids of the type studied possess certain chromatographically desirable properties, such as low solubility and dimensional stability, which render column operation possible[2] in spite of the fact that their acid-combining capacity is low. The amino-acid adsorption by these solids was investigated by both column and static experiments. For the column experiments, 10 gm. of sample (− 52 + 72 B.S.S. mesh) was packed wet into a 7-mm. diameter glass tube. 200 ml. of the amino-acid solution containing 10 mgm. each of aspartic acid and glycine was allowed to percolate through the column at a flow-rate of approximately 1 ml. per min. The percolate was

Table 1. Column Adsorptions

Adsorbent	Amino-acid adsorbed (mgm. per gm. adsorbent)	
	Aspartic acid	Glycine
Natural zinc sulphide	0·41	0·24
„ lead sulphide	0·32	0·33
„ lead manganate	0·05	0·00
„ lead sulphate	0·20	0·34
„ barium sulphate	0·04	0·01
„ lead chromate	0·00	0·00
Fused lead chromate	0·00	0·00
Synthetic zeolite	0·72	0·25

collected and analysed for amino-acid content (Table 1) by a quantitative paper chromatography technique using the spot-area method[3]. For comparative purposes a column of a synthetic zeolite was prepared and used under identical conditions.

Since in any column operation there is a limited adsorption time, the relative adsorption-rates of aspartic acid and glycine for both natural and synthetic samples of the solids used in the column experiments were assessed by means of static experiments. In these experiments 1-gm. samples (— 200 B.S.S. mesh) were placed in 100 ml. of an amino-acid solution containing 5 mgm. of each of the above two acids. After intermittent shaking for an average period of six days, 25-ml. aliquots were removed and their amino-acid contents determined chromatographically (Table 2). A sample of synthetic barium chromate was used as an additional adsorbent.

Table 2. STATIC ADSORPTIONS

Adsorbent	Type	Amino-acid adsorbed (mgm. per gm. adsorbent)	
		Aspartic acid	Glycine
Zinc sulphide	Natural	1·96	1·80
	Synthetic	— *	0·44
Lead sulphide	Natural	0·76	0·61
	Synthetic	— *	0·12
Lead manganate	Natural	0·84	0·64
	Synthetic	0·08	0·00
Lead sulphate	Natural	— *	— *
	Synthetic	0·28	0·08
Barium sulphate	Natural	— *	0·44
	Synthetic	0·00	0·00
Lead chromate	Natural	0·60	0·52
	Synthetic	0·40	0·00
	Fused	0·84	0·40
Barium chromate	Synthetic	1·20	0·51
Zeolite	Synthetic	5·00	5·00

* Chromatographic irregularity of ninhydrin-developed spots prevented complete analysis of these aliquots.

From an inspection of Table 1 it can be seen that in all cases (except lead sulphate) the adsorption of aspartic acid was greater than or approximately equal to that of glycine. This observation has been confirmed by the results of the static experiments (Table 2), which show that the amounts of aspartic acid adsorbed on both natural and synthetic solids are decidedly greater than the corresponding amounts of adsorbed glycine. Table 2 also shows that in all available comparisons between natural and synthetic solids, the former exhibited higher adsorptive capacities for both amino-acids.

A study of the mechanism of the process of amino-acid adsorption on sparingly soluble inorganic solids and an attempted correlation between adsorptive capacity and the electrokinetic properties of the adsorbents have been made. An account of such results will be presented in a later publication.

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[1] Buchanan, A. S., and Heymann, E., *Nature*, **161**, 649 (1948); *Proc. Roy. Soc.*, A., **195**, 150 (1948). O'Connor, D. J., and Buchanan, A. S. (unpublished data).
[2] Hamoir, G. C. M., *Biochem. J.*, **39**, 485 (1945).
[3] Bryant, F., and O'Connor, D. J., *Aust. J. Sci.*, **13**, 111 (1951).

Deposition of Metal Films on Jelly-like Materials

SUBSTANCES based on gelatine or agar-agar are used extensively for making moulds, from which replicas can then be made. In order to use the process of electroforming in conjunction with such jelly-moulds, it is necessary to provide the mould surface with a conductive layer. As agar composition, for example, contains about 95 per cent water, it is obvious that the moulds cannot be submitted to drying without causing deformation, and the usual method of coating moulds with aqueous colloidal graphite is therefore inapplicable.

Probably because of the high water-content of the jelly material, it was found to be impossible to produce films by silver-mirror techniques. The metallization by dry metal dust (for example, bronze powder) was rejected as not likely to yield sufficiently accurate reproduction. I have employed various impregnation techniques[1] which are now sufficiently improved to warrant trials in various fields of application.

The surface of the jelly is treated with aqueous silver-ammonio-nitrate made in the usual way. (Note: This preparation, which is widely used by dentists for impregnating natural teeth, is reported to be liable to become explosive. It is inadvisable to store large amounts, and the spent liquid should never be allowed to form crusts or to dry[2].) The liquid is completely evaporated by a jet of compressed air, but a sufficient amount of silver salt is left behind on the surface of the jelly. Instead of exposing this now to gaseous hydrogen sulphide (the resulting silver sulphide is brittle, unstable in acid solutions, and will not adhere to the jelly), the impregnated mould is exposed to *red* selenium, which is dissolved, for example, in carbon disulphide. Immersion in this solution for one to twenty minutes will produce a film of metallic appearance which probably consists of silver or silver selenide. It is transparent to light, conducts an electric current, but may float off when immersed in aqueous media. The film is obviously situated on the surface of the water-soluble silver salt, which was previously left by evaporation on the surface of the jelly. It is sufficiently stable to act as protection for the remainder of the salt, which can now be reduced to metallic silver, trapped as it is between the jelly and the silver selenium film. Suitable reducing media are some photographic developers, hypophosphorous acid (10 per cent), hydrazine-hydrate, etc., in which the treated mould will quickly be covered with a dense opaque film of high conductivity on which electrodeposition may be carried out. As an alternative, nascent hydrogen can be employed, which is evolved at the surface of the mould by making this the cathode in a cell containing acidified water. Apparently the conductivity of the initial silver (or silver selenium) layer is sufficient for this purpose, and soon the bulk of the silver salt is reduced to a dense metallic film.

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June 10.

[1] Rosenstiel, E., *Dental Record*, **70**, 105 (1950).
[2] Upton, P. B., *J. Electrodep. Tech. Soc.*, **22**, 45 (1947).

FORTHCOMING EVENTS

Monday, July 14—Thursday, July 17

INSTITUTE OF SEAWEED RESEARCH (in the Department of Zoology, The University, Edinburgh).—International Seaweed Symposium.

Tuesday, July 15

FAUNA PRESERVATION SOCIETY (at the Zoological Society of London, Regent's Park, London, N.W.8), at 4.15 p.m.—General Meeting.

Thursday, July 17

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Symposium on "The New Anti-Malaria Drug—Daraprim" (Speakers: Brigadier J. S. K. Boyd, Dr. G. H. Hitchings, Dr. I. M. Rollo and Dr. L. G. Goodwin).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade A (with a degree in chemistry, or A.R.I.C.) IN CHEMISTRY at the Coventry Technical College—The Director of Education, Council House, Coventry (July 19).

LECTURER IN CHEMISTRY in the Chemistry and Biology Department—The Registrar, Technical College, Sunderland (July 19).

RESEARCH ASSISTANT (with a degree in physiology, biochemistry or chemistry) IN CHEMICAL PATHOLOGY—The Secretary, Bristol Royal Infirmary, Bristol 2 (July 19).

RESEARCH OFFICER (male; a good honours degree in Science essential, together with a strong horticultural or agricultural background and some aptitude in mathematics or experience in the use of statistical methods) to maintain liaison between the Statistics Section and the N.A.A.S. Experimental Horticulture Stations and Provincial Experiments Committees undertaking experiments on fruit—The Secretary, East Malling Research Station, Maidstone, Kent (July 21).

EXPERIMENTAL PHYSICIST (with an honours degree in physics or its equivalent, and a particular interest in applied electronics) in the Physiology Department—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (July 25).

LECTURER IN AGRICULTURE (with special reference to poultry husbandry)—The Secretary, The University, Edinburgh (July 26).

LECTURER IN AGRICULTURE (with knowledge of farm mechanization, including field engineering and surveying and the principles of construction of farm buildings)—The Secretary, The University, Aberdeen (July 26).

SENIOR LECTURER or READER, and a DEMONSTRATOR, IN THE DEPARTMENT OF PHARMACOLOGY—The Registrar, The University, Leeds 2 (July 28).

ASSISTANT RESEARCH OFFICER/RESEARCH OFFICER IN THE SPECTROCHEMISTRY SECTION of the National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, August 2).

EXPERIMENTAL OFFICERS at R.A.F. Signals Experimental Establishments in Bedfordshire and near London: SENIOR EXPERIMENTAL OFFICER (Ref. D.17/52A) for the development of calibration procedure for radio test equipment and preparation of calibration publications, etc.: an EXPERIMENTAL OFFICER (Ref. D.18/52A) and ASSISTANT EXPERIMENTAL OFFICERS (Ref. D.19/52A) for the calibration of transfer standards (*a*) involving frequency and pulse measurements, and maintenance of the frequency standard, (*b*) involving bridge and miscellaneous measurements, and (*c*) involving output and attenuation measurements—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (August 14).

ASSISTANT IN THE DEPARTMENT OF PSYCHOLOGY (qualifications in educational psychology are essential)—The Assistant Secretary of University Court, The University, Glasgow (August 15).

SENIOR LECTURER IN PHILOSOPHY at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

SENIOR RESEARCH OFFICER IN THE PROCESS DEVELOPMENT DIVISION of the National Chemical Research Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, August 15).

SMUTS MEMORIAL FELLOWSHIP of Cape Town for research in botanical work on the South African flora, preferably in the systematics and geographical distribution of the South African flora—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, August 15).

PROFESSOR OF PHYSIOLOGY—The Registrar, South African Native College, P.O. Fort Hare, C.P., South Africa (August 31).

CHAIR OF PHYSICS at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 18).

POSTGRADUATE SCHOLARSHIP FOR TRAINING IN INDUSTRIAL RESEARCH—The Director, Institute for Industrial Research and Standards, Glasnevin House, Ballymun Road, Dublin (October 31).

ASSISTANT LECTURER IN CIVIL ENGINEERING, a READER or LECTURER IN MINING ENGINEERING, and a RESEARCH ASSISTANT IN THE DEPARTMENT OF MINING AND FUELS—The Registrar, The University, Nottingham.

BOTANIST (woman) in the Department of Agriculture, Tanganyika, for the selection, breeding and general improvement of crops, in particular food crops such as sorghums and maize, conducted mainly at the Ilonga Experiment Station, Kilosa—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27059/323.

CHEMIST in the Ministry of Supply at Chorley, Lancs, to control inspection of (*a*) propellants, powders, explosives, also filling and assembly of associated stores including Service ammunition, rocket charges, etc., (*b*) materials and components used in filler's components and for respirators, etc., (*c*) manufacture of ammunition packing cases including control of wood preservative, and (*d*) metal plating processes—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.463/52A.

EDUCATIONAL PSYCHOLOGIST (with honours degree in psychology; training in recognized Clinic and teaching experience essential) in Child Guidance Clinic—The Medical Officer of Health, Civic Centre, Southampton.

ELECTRICAL ENGINEER to the Central Waterpower Irrigation and Navigation Commission, India—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.567/51-0-A).

GRADUATE IN CHEMISTRY, PHYSICS or ENGINEERING (for the speedy assessment and solution of current problems in industrial packaging the ability to write reports for the layman is essential)—The Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. DPTO.

INVESTIGATORS (qualified metallurgists, chemists and physicists) to study various problems in the fabrication and use of non-ferrous materials—The Secretary, British Non-Ferrous Metals Research Association, 81-91 Euston Street, London, N.W.1.

LECTURER IN PHYSIOLOGY—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

LECTURER IN ZOOLOGY to teach up to B.Sc. degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

METEOROLOGICAL ASSISTANTS in the Falkland Islands Dependencies Survey, for service either at Port Stanley or in the Antarctic Dependencies—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.38135.E.

PHYSICIST at the Ministry of Supply Chemical Defence Experimental Establishment, Porton, Wilts, to undertake research work in connexion with the application of chemical formulations for the control of pests of public and animal health and agricultural importance—The Under-Secretary of State, Research Department Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

POLLUTION INSPECTOR (with a degree in chemistry and, preferably, with experience in the treatment of polluting liquids or in the control of pollution of surface waters) in Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27106/61/52.

PRINCIPAL—The Registrar, University College of Wales, Aberystwyth.

PRINCIPAL PHYSICIST by the Division of Atomic Energy (Production) Research and Development Branch, Culcheth, Warrington, to be responsible for the research work of a physics laboratory, applying physical methods to the study of metals, and to the development of methods of control of new metallurgical processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 331.

SENIOR AGRICULTURAL CHEMIST, Jamaica, for general advisory and investigational work in agricultural chemistry—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27106/60.

SENIOR LECTURER IN TECHNICAL CHEMISTRY—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

SOIL CHEMISTS (Ref. 'Soil Chemist 408'), PLANT BREEDERS (Ref. 'Plant Breeder 422'), and an AGRONOMIST (Ref. 'Agronomist 411'), in the Research Division of the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting the appropriate Ref.

STAFF for experimental work in connexion with combustion and heat transfer in boilers—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. A.15.

WELL SUPERINTENDENT (with at least 10 years experience in mining or well-sinking, and accustomed to the use of mechanical equipment and explosive) in the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting "Well Superintendent 1814".

REPORTS and other PUBLICATIONS

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